PROCEEDINGS

OF THE

AMERICAN ACADEMY

OF

ARTS AND SCIENCES.

VOL. III.

FROM MAY, 1852, TO MAY, 1857.

SELECTED FROM THE RECORDS.

BOSTON AND CAMBRIDGE:
METCALF AND COMPANY,
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Three hundred and sixty-second meeting.

May 25, 1852. — ANNUAL MEETING.

The PRESIDENT in the chair.

Professor Lovering presented the annual report of the Treasurer, in his absence, for the past year, a part of which was read by the Recording Secretary. It was then accepted.

The annual report of the Committee on the Library was read by Dr. A. A. Gould, and accepted.

The annual report of the Committee of Publication was read by Professor Lovering, and accepted.

Professor A. Gray, in behalf of the committee to whom was referred the amendment of the third section of Chapter VII. of the Statutes of the Academy, proposed by Dr. B. A. Gould at the last statute meeting, recommended that it be adopted; namely, that the second clause of the third section of Chapter VII. of the Statutes of the Academy be replaced by the following: —

"The Council for Nomination shall consist of the President and the two Secretaries, together with three Fellows from each of the three Classes of the Academy, to be elected by ballot at the annual meeting. And it shall be the duty of the Council, in nominating Associates and Foreign Honorary Members, to consult the wishes of that section of the Academy to which the candidate, if elected, would belong."

Dr. W. F. Channing exhibited several fine positive photographic pictures on paper, made by Mr. Whipple by simple superposition of the negatives taken on glass. Dr. Channing stated that this process was interesting as the beginning of a new and beautiful art; the original picture taken by the camera on glass being thus susceptible of indefinite multiplication on paper.

The Scrutineers reported that the following gentlemen were elected officers for the ensuing year, viz.: —

Jacob Bigelow, ...	*President.*
Daniel Treadwell, . .	*Vice-President.*
Asa Gray, ...	*Corresponding Secretary.*
Benjamin A. Gould, Jr., .	*Recording Secretary.*
Edward Wigglesworth, .	*Treasurer.*
Nathaniel B. Shurtleff,	*Librarian.*

The several Standing Committees were appointed as follows: —

Rumford Committee.

Eben N. Horsford, Joseph Lovering,
Daniel Treadwell, Henry L. Eustis,
Morrill Wyman.

Committee of Publication.

Joseph Lovering, Louis Agassiz, William C. Bond.

Committee on the Library.

Augustus A. Gould, D. Humphrey Storer,
Benjamin A. Gould, Jr.

The following gentlemen were chosen Members of the Council for nominating Foreign Honorary Members, viz.: —

Benjamin Peirce,
William C. Bond, } of Class I.
Joseph Lovering,

Louis Agassiz,	of Class II.
Charles Pickering,	
John B. S. Jackson,	
James Walker,	of Class III.
Cornelius C. Felton,	
Nathan Appleton,	

On motion of Professor Agassiz, it was

"*Voted*, That a committee, consisting of the Secretaries and the members of the Committee of Publication, be appointed to revise the arrangement of the list of members into sections, with a view to its permanent adoption."

On motion of Dr. W. F. Channing, it was

"*Voted*, That a committee be appointed to revise the language of Chapter VII. of the Statutes of the Academy."

Messrs. W. F. Channing, A. Gray, and B. A. Gould, Jr. were appointed that committee.

On motion of Dr. B. A. Gould, Jr., it was

"*Voted*, That in all future nominations of candidates for election to the Academy, the section to which the candidate, if elected, would belong shall be specified in writing."

President Hitchcock exhibited some fossil fruits and seeds from the lignite deposit associated with the iron ore at Brandon, in Vermont. He was of opinion that they belonged to the tertiary formation, but whether to the miocene or pliocene, he was doubtful.

On motion of Professor Lovering, it was

"*Voted*, That the thanks of the Academy be presented to Hon. Edward Everett, late Vice-President, to Dr. Augustus A. Gould, late Corresponding Secretary, to Mr. Joseph Hale Abbot, late Recording Secretary, to Mr. J. Ingersoll Bowditch, late Treasurer, and to Dr. Henry I. Bowditch, late Librarian, for the efficient and valuable services they have rendered to the Academy in their respective offices."

On motion of Professor Peirce, it was

"*Voted*, That a monthly meeting be held on the second Tuesday of each month of the approaching summer, at eight o'clock, P. M., in the Academy's hall."

Three hundred and sixty-third meeting.

June 8, 1852. — ADJOURNED ANNUAL MEETING.

The PRESIDENT in the chair.

The Recording Secretary being necessarily absent, Professor Lovering was chosen Recording Secretary *pro tem.*

Professor Lovering, in behalf of the committee appointed at the last meeting to revise the classification of Fellows and Honorary Members of the Academy, presented a revised classification, together with the following report.

"1. That the word *section* be substituted for *division*, as the name of the subdivisions of the classes;

"2. That the second section of Class II., originally named the Division of *Botany and Vegetable Physiology*, be known as the Section of *Botany;*

"3. That the third section of Class II., originally named the Division of *Zoölogy and Animal Physiology*, be known as the Section of *Zoölogy and Physiology;*

"4. That the first section of Class III., originally named the Division of *Moral and Intellectual Philosophy*, be known as the Section of *Philosophy and Jurisprudence;*

"5. That the second section of Class III., originally named the Division of *Philology and Ethnology*, be known as the Section of *Philology and Archæology;*

"6. That the third section of Class III., originally named the Division of *Politics, Political Economy, and Jurisprudence*, be known as the Section of *Political Economy and History;*

"7. That the fourth section of Class III., originally named the Division of *Æsthetics*, be known as the Section of *Literature and the Fine Arts;*

"8. That the revised classification of the Fellows, Associate Fellows, and Foreign Honorary Members of the Academy, herewith reported, be permanently adopted by the Academy."

The report of the committee was accepted, and the amendments recommended were adopted by the Academy. The classification recommended was laid upon the table until the next meeting, for examination by the Fellows of the Academy.

Hon. S. A. Eliot stated to the Academy, that the Corporation of Harvard University had received letters from Professors Bache and Henry, urging upon their attention the claims of Gould's Astronomical Journal, and inquiring whether some appropriation for its support could not be made from the funds of the Observatory. The Corporation being of opinion that they could not act directly in the matter, and being at the same time anxious to promote to the extent of their power this honorable undertaking, had appointed the President and the Treasurer a committee to confer with any committee which the Academy might be disposed to appoint, as to the means best adapted to give a permanent support to this Journal.

Mr. Eliot moved that the Academy appoint such a committee of conference.

Professor Peirce made some remarks in regard to the great importance of the Journal for astronomers, and to the high esteem in which it was held in this country and in Europe. He stated that its circulation was as large as that of Schumacher's *Astronomische Nachrichten*, while, at the same time, it was impossible that this Journal, or any other one of a severe scientific character, should be sustained by its subscription list alone. He hoped that steps would be taken to put it upon a permanent basis, and therefore seconded the motion of Mr. Eliot.

The resolution was adopted. Messrs. N. Appleton and Peirce were appointed to act as a committee on behalf of the Academy.

Dr. O. W. Holmes exhibited a more nicely constructed model of the microscope recently described by him at a meeting of the Academy. He observed that the effects of oblique light were very brilliant in exhibiting certain objects, as, for example, the blood-globules; and that no difficulty was experienced from the position of his instrument, when fluids were used. He also exhibited the contrivance which he had substituted for the common method of graduating the aperture, so as to darken more or less the field of view.

Messrs. Channing, Agassiz, Eliot, A. Gray, Shurtleff, and Emerson were appointed a committee to consider the propriety of a course of public lectures to be given by Fellows of the Academy, or other ways of increasing the fund for publication.

Professor Agassiz offered by title two papers: —

1st. Monograph of the North American Crawfishes (Astacidea).

2d. Investigation of some Points of the Natural History of the Higher Animals, bearing upon the Origin, Unity, and Diversity of Man.

Three hundred and sixty-fourth meeting.

June 22, 1852. — MONTHLY MEETING.

The CORRESPONDING SECRETARY and subsequently the PRESIDENT in the chair.

Professor Agassiz, in behalf of the committee appointed to consider the best means of increasing the Academy's publication fund, reported that the committee were unanimous in recommending that a course of public lectures of a popular character be given by Fellows of the Academy during the ensuing winter; that the President be requested to commence the course by an address, setting forth the objects and aim of the course, and that each Section of the Academy appoint one of its number to deliver one lecture upon some special subject belonging to, and prominent in, the Section's sphere of research.

He offered the following resolution: —

" *Resolved*, That the President appoint a committee of twelve, consisting of one Fellow from each Section of the Academy, whose duty it shall be to call together their respective Sections for the selection of lecturers; and to appoint a sub-committee for attending to the necessary arrangements for the delivery of the course of lectures."

The resolution was adopted, and the following gentlemen were appointed, the President, on motion of Mr. Emerson, being requested to represent the Section of Botany: Messrs.

Peirce, J. I. Bowditch, Lovering, Treadwell, Alger, J. Bigelow, Agassiz, H. I. Bowditch, Bowen, Felton, Everett, Eliot.

On motion of Dr. B. A. Gould, it was

"*Voted*, That, with a view to the speedy and permanent adoption of some classification of the Academy into Sections, the arrangement as already reported by the committee be printed for better examination by Fellows."

Professor Agassiz called the attention of the Academy to some facts in natural history throwing light upon and illustrating the diversity of origin of the human race.

In the first place, he showed that there were a number of animals, among which were particularly to be instanced the anthropoid monkeys, which offered the same difficulties to the zoölogist in classifying them that are offered by the different human races. The orang-outangs, which have been divided by some into four species, have been considered by other naturalists as forming but a single one. The genus of long-armed orangs (Hylobates) is considered by some as containing eleven species, while others make but two or three. The lions of Asia and Africa, which, resembling one another too closely to permit of a proper distinction as two species, present points of difference far too marked to allow the idea of any genetic connection. Mr. Agassiz also instanced several other analogous cases among vertebrated animals.

Secondly, the areas within which the several varieties of such animals are confined are not very different in extent from those within which distinct human nationalities have been developed and have fulfilled their respective missions, such as Greece, Italy, Spain, &c.

The languages of different races of men were neither more different nor more similar than the sounds characteristic of animals of the same genus, and their analogy can no more be fully accounted for on any hypothesis of transmission or tradition than in the case of birds of the same genus, uttering similar notes in Europe and in America.

In the last place, Mr. Agassiz spoke of the character of the differences between the several divisions in man and in many of the lower animals; divisions too marked to be deemed simply varieties, and yet not sufficiently great to constitute a proper basis for a classification into different species. They might, with more propriety, be termed races. The different kinds of dogs, breeds of cattle, &c. were instances of this sort of difference. Animals, differing only in race, form more frequent connection with one another than those differing specifically, and the fruit of connections of the latter kind, like the mule, the mulatto, or the mongrel, were intermediate between the two parents, and still capable of producing to a certain extent.

Three hundred and sixty-fifth meeting.

July 13, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Peirce presented a communication upon the Solution of Equations by the Means of Geometric Diagrams.

Professor Peirce also presented a communication upon the form assumed by an elastic sac containing a fluid.

The positions of unstable equilibrium he found to divide themselves into four special forms, the annular, cylindrical, that of the cylinder with a bilateral character, and the double or multiple cylinder. The ultimate form of the first case is a sphere.

He also alluded to the interest of this fact to those who were not themselves mathematicians. For the primitive forms which Professor Agassiz had found to be the four types of the animal kingdom were the same, the Radiata being represented by the sphere, the Mollusca by the cylinder, the Articulata by the bilateral, and the Vertebrata by the double cylinder. Now, as all animal forms begin as elastic sacs, containing fluids, these forms seem the necessary ones for the condition of equilibrium.

This led to a discussion, in which Messrs. Eustis and Peirce took part.

Professor Wyman exhibited to the Academy some fossil bones from New Zealand, evidently the thigh-bone, tibia, and tarsus of some one of the largest birds, probably either the *Dinornis* or *Palapteryx.* The tarsus was especially interesting, as exhibiting the rudiments of two bones besides the developed one, bones of which no traces exist in other birds except in the embryonic state; a phenomenon analogous to that occurring in the metatarsal bones of Ruminants.

Professor Peirce communicated some observations of Messrs. Southworth and Hawes, daguerreotypists, in relation to photographic images taken for the stereoscope. They had found in practice, that, when two points of view were in a horizontal line, the image as seen in the stereoscope appeared distorted, in consequence of the horizontal lines not being represented in relief, like the vertical ones. They had, however, observed that the best images were produced when the position of the two points of view was such that the vertical component was equal to the horizontal one.

Professor Peirce stated that he had seen a number of phototypes taken in each way, and that he was able to confirm the statements of Messrs. Southworth and Hawes, that portraits taken with two points of view on the same level had a peculiarly unpleasant effect.

Professor Lovering reminded the Academy that Leonardo da Vinci had pointed out the impossibility of representing objects correctly in pictures when their distance from the eyes was within a certain limit.

Dr. B. A. Gould said that the circumstance of objects appearing in relief when observed in ordinary binocular vision might be explained like the outness recognized in monocular vision, by means of the imaginative and suggestive faculties acting unconsciously on reflection. It seemed but natural that a difference of level in the points of view should be necessary to make relief manifest in systems of horizontal lines.

The discussion was continued by Messrs. Peirce, Gould, and C. T. Jackson.

Professor Eustis gave a new demonstration of the property of the ellipse, that the subtangent is independent of the conjugate axis. He showed that this led to a more simple construction than any other given.

Three hundred and sixty-sixth meeting.

July 26, 1852. — ADJOURNED MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary presented a paper from Dr. Leidy of Philadelphia, upon the Osteology of the *Hippopotamidæ.*

Professor Peirce continued his remarks upon the forms assumed by an elastic sac containing fluid, and stated that he had succeeded in reproducing them artificially by the use of gum, the force of gravity being eliminated, as in Plateau's experiments, by immersing the gum in a mixture of alcohol and water of the same specific gravity.

Three hundred and sixty-seventh meeting.

August 10, 1852. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Dr. Pierson offered a tribute to the memory of the late Thomas Cole, Esq., a Fellow of the Academy; after a sketch of Mr. Cole's life and labors, he offered the following resolutions, which were unanimously adopted: —

" *Resolved*, That the Academy deplores, in the death of its late Fellow, Thomas Cole, Esq., of Salem, the loss of a valuable and active associate, whose simplicity of mind, sincerity of heart, and intellectual acquirements, the result of years of persevering industry, peculiarly fitted him for scientific pursuits, and acquired for him a cordial regard from all who knew him.

" *Resolved*, That the Academy sincerely condole with his bereaved family in the affliction occasioned by his sudden decease.

" *Resolved*, That a copy of these resolutions be transmitted to the family of the deceased."

Three hundred and sixty-eighth meeting.

September 14, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. M. Wyman communicated to the Academy the results of some experiments upon animals, with a fluid obtained by distilling water and fusel-oil from chloride of lime, in the usual way of manufacturing chloroform, substituting only fusel-oil for alcohol.

A large, strong rat was placed in a quart "beaker-glass" with its mouth upward, and covered with a glass plate. A piece of cotton, well moistened with the fusel-oil compound, was placed in the vessel. In five minutes, no effect being produced, an equal quantity of the compound was poured upon the cotton; in thirteen seconds, another and equal quantity added. In thirty minutes the rat was washing its face with its paws, and licking its body; in forty minutes, it was apparently well. Fresh air was admitted into the vessel at each addition of fusel-oil compound.

Half a fluid drachm of chloroform was placed in the vessel. In one minute and five seconds the rat had rolled upon its side; in two minutes it was motionless; in three minutes and fifteen seconds it was dead.

A young kitten, exposed to the compound nineteen minutes, was not injured. It sucked the mother immediately after. Another kitten, of the same litter, was exposed in a similar vessel to the vapor of chloroform. In two minutes it became insensible, and was removed from the vessel; in two minutes twenty-three seconds it partially recovered, and was returned to the vessel; in eight minutes it dropped again; in eight minutes fifty seconds it was gasping; in nine minutes it was again insensible. It was removed from the vessel, and finally recovered.

Several other experiments were tried upon kittens, and upon frogs, both with the fusel-oil compound alone and mixed with the vapor of chloroform, and the conclusion was inevitable that the vapor of the fusel-oil compound was not alone injurious to animal life, and that mixture with the vapor of chloroform did not modify its effects upon the animals exposed to it.

The vapor of the fusel-oil compound was subsequently inhaled steadily by Dr. Wyman twelve minutes, without any sensible effects. Chloroform produced a decided effect in two minutes.

The fusel-oil compound is vaporizable at a much higher temperature than chloroform, and when a mixture of the two is exposed to the air, the chloroform evaporates, leaving the fusel-oil compound behind.

The fusel-oil compound, therefore, is not the cause of the occasional fatal effects of chloroform, as has been alleged.

Dr. Wyman stated that these experiments had been made in consequence of a statement which had been published concerning experiments on the same subject, said to have been recently made, with very different results.

Dr. W. I. Burnett presented a paper upon the Formation and Function of the Allantois. After alluding to the difficulties attending the study of this subject, and to the various opinions entertained by different embryologists as to its origin and function, he proceeded to state the results of his own observations.

"These were made upon mammals, birds, and reptiles. But as in these three classes there are no essential differences, the phases of formation in birds, which are most convenient for study, may be described as exponents of the whole.

"In the chick the allantois first appears at about the sixtieth hour of incubation. At this early period, the abdominal plates inclose no organs, except the heart, with its ascending and descending aortas, and the Wolffian bodies. There is then no trace of an alimentary canal, or any of its appendages.

"At this early period, the Wolffian bodies consist of two tubes, one on each side of the vertebral column, running from the region of the heart to the caudal extremity.

"From each of these tubes there then project short digitations, which are to be the future uriniferous tubes of this organ; the original tube becoming the duct of them all in each organ.

"These ducts pass down to the last caudal vertebræ, over which they turn and come together; at their point of junction appears a small vesicle, the expansion of their combined extremities. This vesicle — a minute sphere, and scarcely to be distinguished from the extremities of the ducts themselves — is the *allantois* in its earliest condition.

"At first its walls are extremely thin, being of a most delicate membrane; but as its size increases, cells appear upon its inner surface, and at last a basement membrane is perceived, covered with epithelial cells. All these formative changes have taken place beneath the investing membrane of the whole embryo, and directly at the point of the branching of the two umbilical arteries.

"As the vesicle expands, it pushes out, first, the branches of these arteries which rest upon it, and by anastomosis form a network; second, a hood of the membrane investing the whole embryo. In less than a day after this, when the vesicle has attained the diameter of one sixteenth of an inch, the network of vessels united in the hood of the investing membrane has so increased, that it seems to form the vesicle proper, the original membrane being entirely masked. At this period the allantois has very much the aspect of a diverticulum of the investing membrane of the embryo, and to this perhaps is due the opinion of Coste as to its origin.

"After this it increases rapidly, the spherical vesicle becoming flask-shaped, and extending out quite beyond the caudal vertebræ, around which it passes to reach the dorsal surface of the embryo. Here it meets the amnion, with the membranes of which it partly blends, and in this way serves to conduct to it the umbilical vessels.

"Such is its mode of formation. Its functional relations are equally interesting.

"I would remark, in the first place, that the Wolffian bodies are truly depurating organs of the blood; in fact, are the temporary kidneys of the embryo. We have seen that the allantois appears as the bulbous termination of their combined ducts, at a very early period of embryonic life. But it does not arise until the Wolffian bodies have attained a functional power; that is, until uriniferous tubes are formed having direct relations with the bloodvessels. Indeed, the allantois, as the receptacular termination of the ducts of the Wolffian bodies, is not formed until a urinary secretion is produced.

"These facts, joined with the very significant one, that Jacobson found uric acid in the liquid of the allantois at a very early period, seem clearly to indicate that the primary physiological function of the allantois is to serve as a urinary bladder. This office it serves during the whole period of the persistence of the Wolffian bodies, or until the involution of its neck with the intestine changes the anatomical relations of its ducts. Its subsequent function, however, is different, and of a more important character.

"In the mammalian Vertebrata, the embryo forms vascular and nutritive connections with the mother at so early a period that the new being exists but for a *little time* under *independent conditions*. As soon as there is direct vascular connection by means of the chorion, the independent life of the embryo ceases, and its nutrition, respiration, and other necessary functions, are performed by the mother.

"But until this period, the allantois exercises a most important function, namely, that of respiration. Its surface is covered with a close network of bloodvessels, closely resembling the pulmonary structure of the lower vertebrates.

"In the embryos of the ox and goat, so young that no vascular connection had taken place with the mother, I have seen the provisional blood-corpuscles (which are at first only simple epithelial cells) become oxygenated, acquiring a red color, from circulating in these vessels.

"The allantois is then probably a temporary pulmonary organ; the form of respiration being of the lowest order, and quite in character with the condition of the embryo, that is, aquatic.

"While performing this function it extends to the chorion, blends with its membranes, and its vessels pass over to it (the chorion.) In this way the independent relations of the embryo cease, and the Allantois as a distinct organ entirely disappears.

"In the oviparous Vertebrata, the embryonic conditions are different. Of these the birds and true reptiles alone have an allantois and amnion. Here the functional importance of the allantois appears greater than in the division just described.

"Undoubtedly it serves here, as in Mammalia, as a urinary bladder during its earliest conditions. But its respiratory function soon appears prominent. It increases rapidly, and ultimately envelops the embryo, yolk-sac, and amnion. With these relations it performs the function of respiration by two methods: first, by means of the oxygen of the liquid in its membranes; and second, by bringing a dense network of vessels in contact with the air, which passes through the pores of the shell and surrounds the whole formation. In the latter stages of the embryonic development, it is probable that this second method is most efficient, because most direct.

"From these facts we may conclude that the allantois is, *anatomically*, an appendix of the Wolffian bodies, and not of the intestinal canal, as has been supposed; that its subsequent connection with the intestine is produced by an involution of the membranes of this last around the peduncle of the former. But whether this connection is ever a direct and tubular one, I have been unable to determine.

"*Physiologically* it is at first the receptacle of the urinary secretion of the Wolffian bodies; but afterwards and ultimately it is a respiratory organ.

"These conclusions I have arrived at from direct studies, and it will now be interesting to see how they agree with the general facts of the embryonic development of Vertebrata.

"It is evident that, if the allantois is an appendix of the Wolffian bodies, it would be expected to be met with only in those classes where these bodies are found. In other words, wherever we find an allantois, there ought we to find Wolffian bodies, and *vice versâ*.

"These relations, I believe, are true. Thus in mammals, birds, and the true reptiles, we find invariably Wolffian bodies and an allantois. While in the lower oviparous Vertebrata, as in the Amphibia and fishes, there are neither Wolffian bodies nor an allantois.*

"Thus it would appear that the views here advanced of the origin and nature of the allantois, are supported by the general embryological relations of all the classes of Vertebrata."

Professor Agassiz followed with some remarks. After highly complimenting Dr. Burnett's paper, he stated that circumstances had incidentally led him to investigations upon the same subject. He coincided with Dr. Burnett in his observation of facts, but wished the investigation extended to include the region of the Wolffian bodies. He had satisfied himself that these bodies originated in the capillary system of the pellucid area of the embryo. There is a circulation within the transparent area of the embryo long before any circulation of blood takes place; — a circulation of a transparent fluid containing no blood corpuscles, but consisting of a series of cell nuclei in a transparent fluid. From the resolution of a series of these nuclei the circulation originates, and it is entirely confined to the region of the head, in which the heart is formed. He believed that there were three layers of the blastoderma as first represented by C. E. von Baer, and that these layers are essentially distinct.

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* "A remark is here necessary concerning the reputed Wolffian bodies of Amphibia. As is well known, these bodies were first described by Müller more than twenty years since. According to his own description, they differ in almost every respect from the Wolffian bodies of the higher classes.

"After much examination during this last summer, I have failed to recognize in their structure and general relations the characteristics of the Wolffian bodies, and have therefore ventured to rank the Amphibia, in this respect, with the fishes."

As soon as the eighteenth hour after incubation, the basis from which the Wolffian bodies grow may be detected; he believed that these facts had hitherto been entirely overlooked. The terminations of the Wolffian bodies are combined into a vesicle, from which vesicle the allantois is properly a bud.

With reference to the physical deductions of Dr. Burnett, he had one objection to make. Naturalists were too apt to describe the functions of the organs of undeveloped animals by phraseology derived from the functions of animals in a more advanced condition. He believed this to be dangerous, and, notwithstanding the analogy between the allantois and a urinary bladder, as shown by Dr. Burnett, he could not coincide in the inference.

Dr. Burnett said that his views of the Wolffian bodies were quite different from those of Mr. Agassiz, and that he intended to present them, at an early meeting, to the Academy.

Professor Peirce described an experiment upon the forms assumed, and the motions which arose, in a globule of oil held in suspension in an alcoholic solution.

Professor Agassiz called attention to the analogy between these forms and motions, and those which arise in the earliest embryonic cells.

Three hundred and sixty-ninth meeting.

October 12, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President, in behalf of the committee appointed to provide for the delivery of the Academy's course of lectures, reported that the requisite arrangements had been completed. The course was given as follows, commencing on Wednesday evening, October 27th, at half past seven o'clock, and continued on successive Wednesday evenings: —

By Jacob Bigelow, M. D., President, Introductory Lecture.

By Professor L. Agassiz, Genealogy of the Animal Kingdom.

By Professor C. C. Felton, Relation of Aristophanes to his Times.

By George Ticknor, Esq., The Tartuffe of Molière.

By Dr. B. A. Gould, Jr., The Theory of Probability.

By Daniel Treadwell, Esq., The Progress of the Useful Arts, and their Relation to Scientific Discovery.

By President Edward Hitchcock, The Bird Traces of Connecticut River.

By Lieutenant Charles H. Davis, Astronomical Prediction.

By Professor C. C. Felton, Aristophanes, Second Lecture.

By Professor Albert Hopkins, Time.

By Oliver Wendell Holmes, M. D., The Relations of Poetry and Science.

By George B. Emerson, Esq., A Higher Course of Instruction in Science in Reference to Preparation for exercising the Useful Arts.

By Hon. Samuel A. Eliot, A Complete System of Public Education.

Mr. Horsford exhibited to the Academy specimens of his newly invented safety-lamp and safety-can, and described the precautions which had been taken to guard against accidents.

Dr. W. I. Burnett read a paper upon Cartilaginous and Osseous Tissues.

"The cartilaginous tissue, wherever found, is invariably the same.

Two varieties, however, dependent upon degree of organization, are met with: —

"The first is *cellular cartilage*, being of a transient nature, ultimately to be changed into bone. It is composed of nucleated, well-defined cells lying in a semi-solid, punctiform stroma.

"The second is *fibro-cartilage* of a permanent nature, and consisting of the same cells as the first, but which lie in a network of fibrous tissue, which last is only a further developed condition of the punctiform stroma.

"In fibro-cartilage the fibrous tissue may so increase at the expense of the cellular elements, that these last almost entirely disappear, and hence the transition of fibro-cartilage into fibrous tissue.

"From this it will appear that all cartilage is originally the same, that is, *cellular*, appearing as such in the embryo.

"Its formation there, according to my own observation, occurs in the following manner.

"At those points where cartilage and afterwards bone is to appear, there are seen cells which, as to physical characteristics, cannot be distinguished from those which are to form other tissues.

"A part of these cells are condensed into a punctiform stroma, leaving open spaces here and there, in which the original cells in numbers from one to four remain. Thus is ultimately seen a finely granular stroma, inclosing free nucleated cells. This is the true *cellular cartilage.*

"As this stroma is formed closely about the cells, it is not correct to say that cavities are formed in it, and in which the cells lie. For the cell-membrane, lying in direct contact with the stroma, blends with it, the *nuclei* alone, therefore, being left in the cavity; but as these are nucleolated, they resemble cells, and should be thus designated.

"In *fibro-cartilage* the same early changes occur, but the stroma is further developed into a fibrous or fibrillated tissue. Where this has occurred, the cell-nuclei lie in nidiform cavities.

"Cellular cartilage alone is developed into bone. This occurs in the following manner. When the ossific matter is about to be deposited, the vascularity of the cartilage is much increased, having a pinkish hue. Then a kind of liquefaction of the stroma intervening the cells takes place, by which the cartilage-cells appear no longer confined irregularly, but are, for the most part, free to assume any relative position. Soon after this, there is seen with them a tendency to an arrangement in a linear series. The rows thus formed run parallel with the long diameter of the bone, and are separated from each other by the intercellular matrix, which consists of the partially liquefied stroma.

"It is thus that the future bone may be said to consist of a fasciculus of tubes filled with cartilage cells. This intercellular matrix constitutes the primitive ossific rete, in which the calcareous salts are first deposited. This first deposition having taken place, the cartilage-cells are situated in cup-like, or rather cylinder-like, cavities.

"During this time, however, the cartilage-cells, and the substance immediately surrounding them, are likewise changed from the presence of calcareous matter.

"The cells become smaller, and, in contracting, assume irregular forms, and the septa separating the tubes in which they formerly lay become more and more indistinct from the fulness of the calcareous deposition. Finally, a grayish mass is perceived, having little regularity, and variegated in aspect by the presence of strangely shaped bodies, the future Purkinjean corpuscles. But these processes should be described a little more minutely. During the calcareous deposition, the aqueous portion of the tissue disappears, and, the size of the whole being reduced, the cartilage-cells are brought nearer together; the tissue, therefore, is much more compact, but has not lost its original characteristics. The tubes of which we have spoken form the *concentric lamellæ*, in which the corpuscles are regularly arranged; and thus a transverse section shows them to be *solid cylinders* instead of *hollow tubes* as before the calcareous deposition.

"*The cartilage-cells are transformed into the Purkinjean or osseous corpuscles.* This I have clearly observed, and have traced all the phases of the change. Where the cells are in the cup-like cavities, their nuclei are prominent. But as ossification proceeds they gradually crumble away, and by the time ossific matter is deposited in the cell-walls, little of them can be seen. The cells, however, remain in a shrunken state, holding a concentric relation to a continuous cavity of the tube, and which cavity is the Haversian canal. When the cartilage-cells begin to shrink, radiating lines are seen running from each, and in reaching out in every direction, they meet and join those of contiguous cells, and thus a connection is formed on every side.

"The question now arises, What are these canaliculi? Are they, according to Schwann, prolongations of the cartilage-cell membrane;

or, according to Owen and others, radiations of its nucleus? My own opinion is different from either, and for the following reasons. In the first place, the canaliculi do not begin to form until calcareous matter is deposited, and, as the cell-membrane is then either filled with calcareous matter, or partially absorbed, it could not well send out prolongations. Moreover, these last are often of such a length, and so branch and rebranch upon themselves, that such a mode of formation seems hardly possible. To me it appears most probable that they are the channels of escape of aeriform matters from the interior of the cell. For the cell, situated in the midst of an ossifying mass, would retain for some time its animal matter, and this last would ultimately give rise to gases seeking their escape in every direction by percolating the surrounding semi-solid mass. Canaliculi would thus be formed, and these, converging towards the nearest outlet, have therefore been rightly called 'converging tubuli.'

"During these phases of formation, some of the nuclei of the cartilage-cells, or even whole other cells of a small size, may not be dissolved, but become ossified as such. They are then found as cell-like corpuscles scattered through the osseous tissue. It is in this way that I account for the occasional presence, in the spongy tissue of the long bones, of small spherical bodies, first discovered in 1849 by Dr. O. W. Holmes of this city.

"Such appear to be the processes of formation of the compact tissue of the bones of the higher Vertebrata, as I have studied them in fœtal goats.

"The whole process is simply one of *substitution*, with that contraction and modification of form which necessarily ensues when a soft is replaced by a sclerous tissue.

"This process of substitution is carried out everywhere the same, there being, however, variations in some steps of its progress in the different kinds of bones. The spongy nature of the internal or middle portions of some bones appears to be produced by the absorption, by numerous vessels there situated, of the lighter portion of the primitive cartilaginous base, and a consolidation of the remaining portion towards the periphery.

"This is a point, however, having an unusual teleological bearing, for by such process bones possess the greatest combined strength and lightness attainable with the same amount of material.

"These phases of formation just described belong especially to the higher Vertebrata. In the lower classes they are of a much less complicated character. Thus in many fishes the *concentric lamellæ* do not exist, and therefore there has been no linear arrangement of the cartilage-cells. But these cells are ossified *in situ*, and their canaliculi, radiating thence on every side, give to the whole a most regular and beautiful appearance.

"The cartilage of the cartilaginous fishes seems to differ from the common cartilage of the higher Vertebrata. In fact, it cannot be called true cartilage, but is, if I may so express myself, an osseous tissue in a cartilaginous dress.

"This may be explained by a few remarks. Valenciennes* has shown that the cartilage of the cartilaginous fishes and of the Cephalopoda contains *gelatine*, and not *chondrine*.

"Müller † has also shown that all cartilage capable of ossification contains *chondrine*, and not *gelatine*, and that after ossification no *chondrine* is found, but all is *gelatine*. Therefore bones are, so to speak, gelatinous, and not *chondrinous*; which, as we have just seen, is also true of the so-called cartilages of the cartilaginous fishes and Cephalopoda.

"The tissue forming the skeleton of these fishes, as I have had opportunities to examine it, is composed of oval or spherical cells like those of common cartilage at an early period. They have become *hardened in situ*, but not calcarified; and never have I met any having canaliculi radiating from them. From these data we may conclude that in these lower fishes there is *bone-cartilage*, but not true bone."

Professor Agassiz said that he believed naturalists, in considering organic tissues, were altogether too much in the habit of looking at different tissues as if they were entirely distinct bodies, forgetful of the fact that all are derived from one yolk. In considering the first formation of cartilage, we must look to the formation and development of the dorsal cord. We find these cells differing from the blastodermic cells, in being larger, but bearing no resemblance to cartilage-cells, although they form the basis from which the cartilage-cells are built up. He had carefully examined these cells, which, however, presented points of extreme difficulty, but had not yet succeeded in determining whether they were the identical ones which were to be transformed into cartilage-cells, or whether, on the other hand, they were the mother cells, from which the cartilaginous cells would derive their origin.

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* *Compt. Rend.*, Nov. 25, 1844.

† Poggendorff, *Annalen*, Band XXXVIII. p. 316.

Mr. Agassiz further stated that he had examined the cartilage-like bones of fishes, of which Dr. Burnett had spoken, and that he had found the same results.

Professor Eustis gave an account of a formula for the measure of the solidity of a prismoid, and its application to other cases of mensuration.

The ordinary formula for the area of a prismoid is $\frac{1}{6} h (B + b + 4 M)$, where B and b represent the areas of the upper and lower bases respectively, M the middle section, and h the height. The application of this formula for the mensuration of the sphere and the cone is alluded to in a recent number of the Journal of the Franklin Institute. But still more remarkable cases are those of the paraboloid, hyperboloid, and ellipsoid of revolution, in which the prismoidal formula will be found to give precisely the same results as those obtained by the application of the ordinary formulas from the calculus.

Professor Lovering exhibited a new stereoscope just received, and called the attention of the Academy to some points of detail, especially those arising from the difference of effect when the same drawings of a solid are viewed so as to represent it with one side or its opposite nearest to the eye.

Dr. Burnett commented on these facts, as demonstrating the proposition that the seat of vision is in the brain, and not in the retina.

Dr. B. A. Gould addressed some inquiries to Dr. Burnett concerning the best spider-lines for use in the micrometers of telescopes and microscopes.

A discussion ensued upon the qualities necessary in spider-lines for this purpose, in which Messrs. Burnett, Eustis, and Gould took part.

Dr. Burnett thought that the thread of the Attus or hunting spider was the most desirable in all respects, having almost uniformly a diameter of just $\frac{1}{9000}$ of an inch, and being wholly free from viscosity. The Attus is found at this season of the year on rail fences.

Professor Agassiz presented a paper upon the family of the *Cyprinodonts.*

Three hundred and seventieth meeting.

November 2, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Felton reminded the Academy of the recent death of the Hon. Daniel Webster, Secretary of State of the United States, and Fellow of this body; and, after an eloquent tribute to his memory, offered the following resolutions, which, after being seconded by Mr. F. C. Gray, and advocated by Mr. Parsons, were unanimously adopted.

"*Resolved*, That the Fellows of the American Academy of Arts and Sciences deeply lament the decease of their late Associate, the Hon. Daniel Webster, Secretary of State of the United States. By his death the country is bereaved of her ablest practical statesman, and profoundest political philosopher. Letters and eloquence have lost a most distinguished ornament. Science is deprived of a great and versatile mind, which understood its progress, appreciated its value, recognized its dignity, and mastered its results in the midst of professional labors and public cares, to which his energies were devoted almost to the last moment of his life.

"*Resolved*, That the Fellows of this Academy tender to the family of their late eminent Associate, their most respectful sympathy in this private and public calamity."

Three hundred and seventy-first meeting.

November 10, 1852. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary laid before the Academy letters from the Royal Society of London, and the Academies of Göttingen, Berlin, Vienna, and Munich, referring to publications forwarded to the Academy.

A communication from the Royal Society of Northern Antiquaries in Copenhagen, containing circulars relating to the collection of materials for works upon the history of the Old Northern Literature, was laid before the Academy.

Dr. William P. Dexter was elected a Fellow of the Academy.

M. Brown Léquard, of Paris, personally made the following communication.

He stated that he had succeeded in producing muscular irritability, i. e. life in the muscles, after decomposition had commenced, by means of injections of blood, repeated every two or three hours. But the fact of which he wished to speak this evening was quite different. He had found that muscles separated from the body might be maintained in a state of rigidity by the injection of chloroform. After an interval of several days, blood might be again introduced, repelling the chloroform, and reinducing the irritability of the muscles. In one case, after the lapse of ten days, muscular life had been restored by the injection of blood, though the *amount of blood required was much greater than after* a smaller interval. Irritability might also sometimes be introtroduced, though more rarely.

In reply to a question of Dr. Pickering, M. Léquard stated that the blood must be as fresh as possible, though it was capable of producing the effect when an hour old. In one case in Paris, he had found that blood which had been drawn for two hours had sufficed.

With regard to the proper kind of blood for transfusion, he had found that fibrine was not necessary, so that the operation can be performed with defibrinated blood. Bischoff had discovered, that, in those cases where the blood of one animal was poison to another, this quality was due solely to the fibrine, so that defibrinated blood may be used in all cases for transfusion without deleterious results. There is another interesting fact, namely, that animals have more fibrine in their blood when they have not been fed for a long time, than under ordinary circumstances.

Dr. Samuel Kneeland was elected Recording Secretary, in place of Dr. B. A. Gould, who resigned.

Three hundred and seventy-second meeting.

December 7, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Winlock, of Kentucky, made a verbal report on errors he had discovered in Bradley's and Bessel's Observations on the sun, illustrated by diagrams.

Professor Peirce observed that this was a very remarkable application of the method of least squares, leading to the discovery of such a small difference between the printed observations and the true result. He gave other examples of the detection of errors by the application of this method, showing that even errors are regulated by laws. He remarked, that, with all our accuracy, the diameter of the sun is not yet known; the best way to ascertain this is by an eclipse, but even this is open to doubts.

Professor Peirce alluded to several errors attributed to him in some foreign journals; — the idea that the orbit of the comet of 1689 was the same as that of 1843 had been erroneously attributed to him. He believed also that astronomers will yet acknowledge that there are two solutions to the perturbing actions of Neptune on Uranus.

Dr. J. Wyman offered some remarks on the internal structure of the cranium of the mastodon. He had compared the foramina through which the nerves escape from the cranial cavity with those in the skull of the elephant; those transmitting the trigeminus and facial nerves were of similar proportions in the two, and tended to show that the mastodon, as well as the elephant, was provided with a trunk, the large size of the nerves indicating a corresponding development of muscular fibre and of sensitive surface in the face.

The form of the cranial cavity, which has not been described, corresponded with the extraordinary type met with in the elephant, having similarly narrow and contracted anterior lobes, and having the transverse diameter of the encephalon exceeding the longitudinal. Besides in elephants and mastodons, this last condition exists only in Cetaceans. Dr. Wyman remarked upon the transition from the genus mastodon to that of the elephant, as shown by the teeth in the different species discovered by Falconer and Coutley in Asia, and upon the similarity in the forms of the brains, as showing a much closer affinity between the two genera than had generally been supposed to exist.

Three hundred and seventy-third meeting.

January 4, 1853. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. Walter Channing made some remarks on meteorological phenomena noticed by him in a recent voyage to Europe; among others, on the remarkable brilliancy of the nights in Russia compared with those of more southern latitudes.

Dr. W. F. Channing gave an account of the experiments on the velocity of sound, recently made in this vicinity by Captain Wilkes. The discharge of a cannon was made to break the circuit in a telegraph wire, thus marking exactly the time of discharge and the observance of the sound, and avoiding the personal errors of watching for the flash and recording the exact time. He described an instrument of his invention for recording the first vibration of air from the cannon's discharge. The results are not yet fully compared, so as to show the differences arising from the dryness or dampness of the air, change of elevation, intervening hills, &c.

The Treasurer announced a donation from the Hon. Jonathan Phillips, of one thousand dollars, to the general fund of the Academy.

Whereupon, it was unanimously

"*Voted*, That the thanks of the Academy be presented to the Hon. Jonathan Phillips, for the generous contribution of one thousand dollars to its funds, for the purpose of promoting the progress of science."

Three hundred and seventy-fourth meeting.

January 26, 1853. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary laid before the Academy a letter from Professor Rokitansky, accepting membership of the Academy.

The President, on behalf of the sub-committee appointed last year to carry out the plan adopted by the Academy for a course of lectures in Boston, made the following report: —

"That a course of twelve lectures, by members of the Academy appointed for the purpose, has been completed within the last three months in this city.

"Through the liberality of John A. Lowell, Esq., of this city, Trustee of the Lowell Institute, the Academy have been furnished with a lecture-room, lights, attendance, and other accommodations, free of all expense.

"It will appear by the Treasurer's accounts, that a gross sum has been received from the proceeds of these lectures, which, it is believed, will be sufficient, after payment of expenses, to relieve the Academy from its immediate liabilities.

"The Committee are of opinion that the influence of this course of lectures has been beneficial to the Academy, by bringing the institution into nearer contact with the community at large, by making better known its character and claims, and by awakening public sympathy and liberality towards the objects of its pursuit. And they are led to believe that a repetition of such a course in future years may be made both creditable and advantageous to the Academy.

"Under this conviction, the Committee have made application to Mr. Lowell for an arrangement by which one course of the Lowell Lectures shall be delivered next year by members of the Academy, appointed for the purpose, the proceeds of the course to be devoted to the objects of the Academy. To this application, Mr. Lowell has returned an answer, which leads the Committee to believe that no obstacle will exist to carrying out the plan in a manner satisfactory to both parties.

"The Committee therefore recommend the passage of the following votes by the Academy.

" *Voted*, That the thanks of the Academy be presented to John A. Lowell, Esq., for the liberal and satisfactory manner in which he has caused them to be accommodated during the delivery of their late course of lectures.

" *Voted*, That the Academy will appoint twelve lecturers of their members to deliver one course of Lowell Lectures, on such subjects as shall be conformable to the objects of the Lowell foundation, and acceptable to the Trustee of the Lowell fund.

" *Voted*, That a committee be appointed, with full powers to make the necessary arrangements with Mr. Lowell for the above purpose, and also to appoint the lecturers, subject to the approval of the Academy.

" JACOB BIGELOW,
SAMUEL A. ELIOT,
GEORGE B. EMERSON, } *Committee.*

" *Boston*, *January* 20, 1853."

This report was accepted, with a slight modification in respect to the number of lecturers to be appointed; and the former committee, consisting of Dr. Bigelow, Samuel A. Eliot, and George B. Emerson, with the addition of Professor Treadwell and Professor Peirce, were chosen to take the subject in charge.

On motion of Professor Lovering, it was voted that the provisional list of members, printed for the use of the Academy, be permanently adopted.

On motion of Professor Gray, the list was referred to a committee of three, for their examination, to report at a future meeting.

Professor Gray, Professor Parsons, and Mr. Folsom were appointed on this committee.

Professor Peirce made a communication on the Ericsson engine, which has been regarded as showing that heat can be used over and over again as a motive power. The idea that power once used cannot be used again, he considered a fundamental rule, which has only a single exception, that of steam; and even this exception rests on two hypotheses, one assuming as certain the experiments which are said to prove it, and the other assuming that heat is power.

In the first place, he showed that this engine does not use the heat over and over again, and that when the air in the cylinders becomes expanded, in other words, whenever work is done (for no work is done while the piston is descending), heat is lost irrecoverably, and can only be resupplied by more fuel.

In the second place, he showed that, with the same amount of fuel, not so much work was done, nor was it so well done, as by steam. Still it was an exceedingly ingenious and well-perfected method of using hot air as a motive power, and in certain cases may become quite a rival of the steam-engine.

He gave a minute description of the different parts of the engine, illustrated by diagrams. In the large cylinder, the pressure never exceeds five pounds to the square inch, and never can, unless the heat be raised above 550°, which is the maximum temperature said to be used in Ericsson's engine; to get fifteen pounds to the square inch, he must heat his cylinder to 1000°, or to a red heat. Professor Peirce used 480° in his calculations.

This engine has four cylinders, nine strokes a minute, six feet to a stroke, and one hundred and fifty square feet of piston; it is said to consume only six tons of coal a day. Mr. Peirce calculated the working power of the engine to be only 116 horse-power; he compared this with the Baltic steam-ships with 2314 horse-power, twenty times the power of Ericsson's engine. To raise the Ericsson to the Baltic's power, one hundred and twenty tons of coal a day would be demanded, while the Baltic uses only eighty; so that the economy of fuel, one of the great advantages ascribed to the Ericsson, is in reality in favor of steam-vessels. The power of the Ericsson would be nothing against a head sea, and her speed of eight miles an hour on her trial trip is less than steam-vessels of inferior model made ten years ago. As yet the Ericsson engine has not only not surpassed steam-vessels, but has not even equalled them.

As to the alleged saving of heat, the Ericsson loses 60° of heat at each stroke, which must be made up; the maximum heat in the wire-gauze apparatus is 30° below the heat in the cylinders; all the air in the cylinders must have supplied to it 60° of heat. At least one half a pound pressure to the inch, and probably much more, is required to force the air through the wire-gauze.

Dr. Bowditch alluded to the instrument called the "respirator," as analogous in its action to the wire-gauze in Ericsson's engine, in which the heat is often so retained as to be uncomfortable to the patient.

Professor Peirce observed that this apparatus of Ericsson was undoubtedly of great value for the working of his engine.

Professor Treadwell remarked that this same analogy to the "respirator" had been brought forward in 1847 in regard to Stirling's engine, which had an advantage over Ericsson's in using the same air over and over again. Air has an advantage of one half or two thirds over steam in the matter of specific heat, and if it could be used as conveniently without forcing-pumps, &c., it would be far superior as a motive power; but as yet the chief obstacles have not been removed.

Dr. W. F. Channing observed that Professor Peirce, in his calculations, had used the power necessary to double the speed in a given time as the *cube*, whereas, in the published accounts, it had been given as the *square;* and that thus so little power had been left (about $\frac{3}{4}$ lb. working power to the inch), that it seemed quite providential that the vessel had moved at all. To which it was replied, that when the element "space" is taken in the formula instead of "time," the *square* becomes doubled, or the *cube*.

Three hundred and seventy-fifth meeting.

February 1, 1853. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

Professor Lovering reported that the map of the tornado at Medford was engraved, and that the report, by Professor

Eustis, was in the printer's hands, and would probably be finished in a few weeks.

Mr. Charles Jackson, Jr., in reference to the discussion at the last meeting on the Ericsson engine, said that the calculation showed that the efficient pressure was three fourths of a pound per inch in the up stroke, and nothing in the down stroke, or three eighths of a pound average. He did not believe this was enough to overcome the mere friction of the engine, and thought there must be an error in the facts on which the calculation that gave the result was based. He believed the air-engine, working at about 500°, and cutting off at one half or two thirds of the stroke, would give the same result as a non-condensing expansive steam-engine working with fifteen pounds of steam.

Steam at that pressure having about the same weight as common air, but the latent heat of the steam being twice the 500° the air required, and the capacity of water for heat being nearly four times that of air, the steam-engine required eight times as much fuel as the air-engine did. Half the power of the air-engine would be used in working the supply-pump, leaving the air-engine still four times better than the steam-engine even without any regenerator. The amount of heating surface required would be a great deal less with air than with water. In hot-blast iron smelting-furnaces which he has observed, there was five times as much air heated to 600° as there was water boiled off for the engine, and yet the hot-air ovens did not occupy one tenth of the room the boilers required.

Professor Treadwell remarked, that it was a matter of every day's observation, that in regard to the heat-conducting surface of iron necessary with air and with water, the advantage was very much in favor of water, even twenty to one.

Professor Peirce reaffirmed his statements at the preceding meeting, with a few modifications, not changing his general results. He said that accurate measurements by the Coast Survey showed that the actual speed of the Ericsson was only seven miles an hour, which, compared with the speed of the Collins steamers, would make the Ericsson consume twenty-five per cent. more fuel than the latter.

At the former meeting he had not considered the "cut-off," which gives a result more in favor of the Ericsson; though this advantage is compensated by the error he made in favor of the Ericsson engine by taking the heat of the cylinders at 480°, whereas the actual heat used was only 384°. The "cut-off" may be so short that the regenerator would be useless, the air going in and out at the same temperature, though more fuel would be required in this way. The shorter the "cut-off," the greater would be the theoretical power, provided you could get the air in. The "cut-off" in this engine is at three fourths of the stroke; for one fourth of the stroke there would be a pressure of three fifths above an atmosphere, and for the other three fourths of the stroke only one fifth above an atmosphere. One pound pressure would be required to force the air out through the wire-gauze, instead of the half-pound previously mentioned; and one and one fifth pounds pressure to force it in.

Dr. W. F. Channing remarked, that the difference in the loss of power from paddles entering the water (which is great in steam-vessels), and the less amount of friction, give more power to this engine. He thought, that, deducting one pound pressure (necessary to force the air through the wire-gauze) in place of half a pound allowed by Professor Peirce, there is a pressure of only one fourth of a pound left; and deducting from this 40 horse-power (equivalent to two fifths of a pound pressure, by Professor Peirce's calculation) for the loss from the paddles entering the water, and one fifth of a pound of pressure for additional friction, there would be a pressure of *minus seven twentieths of a pound* to an inch inside the cylinder, or, in other words, that the engine was worked by an *outside* atmospheric pressure acting inwards.

Professor Josiah Parsons Cooke and Professor Joel Parker of Cambridge were elected Fellows of the Academy; the former in the section of Chemistry, the latter in the section of Philosophy and Jurisprudence.

Three hundred and seventy-sixth meeting.

March 1, 1853. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary announced that he had received a letter from Professor Parker accepting membership of the Academy. Professor Cooke took his seat as a Fellow.

Professor Treadwell observed, that the speed of the Ericsson in her trip to Washington was about six geographical miles an hour. He mentioned that hundred-gun ships, of a model far inferior to that of the Ericsson, had made nearly twelve miles an hour in trial trips in England, with steam-engines of 350 and 400 horse-power; as this was twice the velocity of the Ericsson, the power required would be eight times that of the Ericsson, which was far from the power used. The Ericsson consumed five tons and a fraction of coal a day; to get double the velocity, as in the English vessels, supposing the resistance the same (which it is not, on account of the vastly superior model of the Ericsson), about forty-five tons would be consumed, which is more than was consumed by the steam-vessels above mentioned. So that the experiment, after all, does not promise much in favor of the caloric engine.

Dr. W. F. Channing observed, that it is admitted that there is a saving of about one third of fuel in the caloric engine; that it must be an important improvement for stationary engines, even if it should not be found compact enough for sea-going vessels. An article in the Scientific American gives to the Ericsson 250 horse-power.

Professor Treadwell remarked, that very nearly as much power could be obtained from the amount of coal used by the Ericsson, if employed in the generation of steam, on account of the far greater expansive power of the latter.

Mr. Charles Jackson, Jr. said that actual experiments by the thermometer have proved that 360° of heat are saved by the regenerator, there being only 30° difference between the temperature of the air going out and that going in.

Professor Gray alluded to a very interesting botanical discovery in this country, namely, the finding of two species of *Trichomanes* in the northwest corner of Alabama; species of a group of ferns, of very delicate texture, usually confined to very moist parts of the tropics, or to islands having a damp climate and equable temperature, but not before known to occur within the limits of the United States.

The small species of *Trichomanes* exhibited by Dr. Gray is doubtless a new species, which he proposes to name *T. Petersii*, in honor of the discoverer, T. M. Peters, Esq. The other is the *Trichomanes radicans*, found in the southwestern parts of Ireland, and also widely scattered in the tropics. Dr. Gray mentioned that the latter is very frequently cultivated in the glazed cases invented by Mr. Ward; without such treatment it is incapable of cultivation.

The wide range of the ferns having been alluded to, a discussion arose on the difficult question of specific characters. Many supposed identical species of animals have been found, on close examination and actual comparison, to be different; and it was questioned whether the same may not be true of the cosmopolite ferns.

Three hundred and seventy-seventh meeting.

April 5, 1853. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Horsford made some remarks explanatory of a part of the fourteenth chapter of Leviticus, in which are described the signs and treatment of "leprosy" in a house.

He alluded to the decomposition of sulphate of iron when subjected to decomposing animal matter, and its change into the sulphuret or iron pyrites. This last oxidates readily, and is one cause of the stains and some other injuries often seen in stones used for building purposes. He mentioned several buildings which had thus been disfigured, and remarked that the Washington Monument would, in course of time, be defaced from this cause.

The leprosy is described as being "in the walls of the house, with hollow streaks, greenish or reddish, which in sight are lower than the wall." And the remedy is given, — the removal of the affected stones, their replacement by others, and the scraping and plastering of the house.

He thought that the "leprosy of the house" alluded to, was caused by the decomposition of this salt of iron; the greenish color being due to the presence of the sulphate, and the reddish to the peroxide of iron. The limestone used for building in that locality he had found to contain iron pyrites.

He also alluded to a leprosy in clothing, arising from a spontaneous change in the improperly cleansed wool from which they were made.

Dr. Bigelow, after alluding to a supposed connection between leprosy and this change in the walls of a house, observed that the cause of epidemics is completely unknown, and that the reference of them to specific causes has always been in proportion to the ignorance of the people.

Professor Jeffries Wyman made a verbal communication on the effects of physical agents on the development of life. He had repeated some of the experiments of Milne-Edwards on the influence of a low temperature and the absence of light on the development of frogs.

The tadpoles experimented upon were those of the common bull-frog (Rana pipiens, *Linn.*). These, under ordinary circumstances, are hatched in the spring, and acquire their full growth during the autumn, when a few undergo their metamorphosis; but in the larger number, this does not take place till the following spring, the tadpole period lasting about one year.

On the 8th of November, 1851, about thirty tadpoles contained in a trough holding about a barrel of water were introduced into a dark closet in a cellar; the water was occasionally changed, and they were well supplied with food, consisting of Confervæ, leaves, grass, and some animal matter. The thermometer in the closet ranged from 33° to about 60° F. They measured, at the time of introduction, between three and four inches in length; as they were probably hatched in the spring, they were therefore about six months old.

During the month of September, 1852, (ten months after they were introduced into the cellar,) a few were removed to another trough, which, though under cover, was exposed to the ordinary light, and the temperature of the air; these tadpoles soon exhibited signs of metamorphosis; their legs were developed and their tails absorbed.

The remainder have now been seventeen months in the cellar, and if (as there can be little doubt) they were hatched in the spring of 1851, they are now (April, 1853) at least nearly two years old. In the mean time they have not materially changed in size; the legs, which were mere rudiments when they were introduced, have not increased; and as far as appears, the tadpoles have no tendency to metamorphosis.

Assuming the natural larva period to be one year (and this corresponds with observation), that period has in this experiment been extended to nearly double its usual duration.

It was noticed, that when the thermometer was at its greatest depression, the tadpoles exhibited a much greater degree of activity than fully developed frogs, exposed in the same closet to the same degrees of light and heat. The tadpoles were frequently moving about, when the frogs were wholly torpid.

Three hundred and seventy-eighth meeting.

May 3, 1853. — MONTHLY MEETING.

The VICE-PRESIDENT in the chair.

The Corresponding Secretary read a letter from Lieutenant J. M. Gilliss, of the United States Navy, presenting, from the

Council of the University of Chili, a copy of the *Anales de la Universitad de Chile,* which was laid on the table.

Professor Peirce made a communication on the caloric engine, in reference to the relations of different gases and vapors to heat.

Professor Treadwell followed, with some remarks on the same subject.

Three hundred and seventy-ninth meeting.

May 24, 1853. — ANNUAL MEETING.

The PRESIDENT in the chair.

The attendance of members being very small, on account of the Inauguration of President Walker occurring on the same day at Cambridge, the meeting was adjourned to May 31st, at half past three, P. M.

Three hundred and eightieth meeting.

May 31, 1853. — ADJOURNED ANNUAL MEETING.

The VICE-PRESIDENT in the chair.

The Corresponding Secretary announced that he had received letters from the Royal Academy of Sciences, &c. of Belgium, and the Royal Society of London, acknowledging the reception of Vol. IV. Part II. of the Memoirs of the Academy; from the Royal Institution of Great Britain, acknowledging the reception of Vol. II. of the old Series, and Vol. II. of the Academy's Proceedings, pp. 233 – 359; a letter from M. Vattemare, presenting, from the Secretary of the Statistical Committee of Belgium, fifteen pamphlets on Political Economy and Statistics, and also urging on the notice of the Academy the advantage of the adoption by all civilized nations of a uniform standard of weights and measures, and of currency; a letter from the Curator of the Museum of Practical Geology of London, presenting, from the British Government, through Sir Henry de la Beche, several valuable works on Geology, published under his superintendence.

The Treasurer presented his report, which was accepted.

Professor Lovering read the report of the Publishing Committee, which was accepted.

Mr. Lovering announced that Vol. V. Part I. of the Academy's Memoirs, and the Map of the Tornado at Medford, were completed, and ready for distribution.

Mr. Lovering then made the following communication: —

"Within a few weeks, as we all know, two of the former members of this Academy have left us, Mr. John Farrar of Cambridge, and Dr. Peirson of Salem, but under circumstances which strangely contrast together. One of these gentlemen died at an advanced age, after a painful and unusually protracted illness, the course of which had been long watched with care and sadness by many friends and admirers. The other was cut off by a terrible accident, in the strength and maturity of his years, and while enjoying health and professional activity. It is more than seventeen years since the sweet and dignified face of Mr. Farrar has been seen at our meetings. On the other hand, it seems but yesterday that Dr. Peirson was with us, eagerly interested in all questions of science which touched his own profession, and that hearty tribute of respect which he so recently paid to an associate in the Academy and a fellow-townsman has scarcely ceased to be heard, when we are called on to offer a similar memorial to him.

"But I rise principally to invite the attention of the members of the Academy to some appropriate notice of the death of Mr. Farrar. Mr. Farrar became a member of the Academy in 1808, and served it in various capacities.

"He was the Recording Secretary for fourteen years. He acted on the Committee of Publication for fifteen years. And he was Vice-President in 1829 and 1830.

"He also contributed the following papers to the Memoirs of the Academy: —

"In the third volume of the Old Series, 'Observations of the Comet of 1811'; — 'Abstract of Meteorological Observations made at Cambridge,' from 1790 to 1807 by President Webber, and from 1807 to 1813 by Mr. Farrar; — 'Abstract of Meteorological Observations made at Andover, by Rev. Jonathan French.'

"In the fourth volume of the Old Series he published 'An Account of the Violent and Destructive Storm of the 23d of September, 1815.' Also, 'An Account of a Singular Electrical Phenomenon, observed during a Snow-storm accompanied with Thunder.'

"Not the least important of the services rendered to science by Mr. Farrar was the translation and introduction into general use in the American colleges of the best French text-books in Mathematics, and Physics or Natural Philosophy; which prepared the minds of teachers and pupils for a system of instruction in these branches superior to that which had hitherto been imitated from the English Universities."

Mr. Lovering concluded with the following resolutions: —

"*Resolved*, That the Academy are deeply sensible of the loss they have sustained by the long illness and recent death of John Farrar, LL.D., formerly Hollis Professor of Mathematics and Natural Philosophy in Harvard College. Although his inspiring presence has not been with us for a period of years which now equals two thirds of a generation, we still remember with gratitude his various official services to the Academy, and his valuable contributions to science in the flower of his life. We remember still the poetical ardor with which he cultivated his favorite sciences, the fervor and enthusiasm with which he taught them, and the rare fascination and eloquence with which he discoursed upon them. We also remember the silent eloquence which beamed from his countenance in sickness and even death. For his rich intellectual gifts, and his Christian dignity and courtesy, which many of us enjoyed so long, we would ever hold him in grateful remembrance.

"*Resolved*, That the Corresponding Secretary of the Academy be requested to communicate these proceedings to Mrs. Farrar, and to assure her of the sympathy which the members of the Academy feel in this her hour of heavy bereavement."

Professor Peirce alluded in terms of admiration to the important services rendered to mathematical science by Mr. Farrar, and ascribed to him, more than to any other man, the adoption of the present admirable system of instruction in the mathematical sciences. He seconded the resolutions offered to his memory.

Professor Treadwell followed in some remarks on the many beautiful traits in the character of Mr. Farrar, and especially on his readiness and willingness to communicate his varied knowledge, and to assist in all ways in his power every student of science, however humble, who might apply to him for advice and instruction. The resolutions of commemoration offered by Mr. Lovering were unanimously adopted.

Dr. B. A. Gould, Jr. called the attention of the Academy to the decease of another of its members, the late Sears C. Walker, to whose labors astronomical science owes much of its recent advancement.

Professor Peirce spoke in the highest terms of the scientific ability and attainments of Mr. Walker, and seconded the resolutions offered by Mr. Gould; which were as follows: —

> "*Resolved*, That the Academy have received with profound sorrow the afflicting intelligence of the death of their honored associate, Sears C. Walker, by whose premature decease American science has lost one of its ablest devotees, and this Academy one of its brightest ornaments.
>
> "*Resolved*, That, in the opinion of this Academy, the labors and enthusiasm of our late associate have signally contributed to the recent advances of astronomy and physics in our own country, while his able and profound investigations have enriched the science of the world.
>
> "*Resolved*, That we offer to the family of Mr. Walker the assurance of our sincerest sympathy in this their great bereavement.
>
> "*Resolved*, That a copy of these resolutions be communicated to the family of our deceased associate."

These resolutions were unanimously adopted.

Professor Gray, in behalf of the committee to whom was referred the revised list of classified members recently adopted, reported some slight corrections, chiefly from the death of members; it was then voted that this list be referred to the Recording Secretary for the addition of new members, and be by him transferred to the Publishing Committee for printing.

The scrutineers reported that the following gentlemen were chosen officers for the ensuing year, viz.: —

Jacob Bigelow, ...	*President.*
Daniel Treadwell, . .	*Vice-President.*
Asa Gray, ...	*Corresponding Secretary.*
Samuel Kneeland, Jr., .	*Recording Secretary.*
Edward Wigglesworth, .	*Treasurer.*
Nathaniel B. Shurtleff,	*Librarian.*

The several Standing Committees were appointed as follows: —

Rumford Committee.

Eben N. Horsford, Joseph Lovering,
Daniel Treadwell, Henry L. Eustis,
Morrill Wyman.

Committee of Publication.

Joseph Lovering, Louis Agassiz, Francis Bowen.

Committee on the Library.

Augustus A. Gould, Benjamin A. Gould, Jr.,
Nathaniel B. Shurtleff.

The following gentlemen were chosen Members of the Council for nominating Foreign Honorary Members, viz.: —

Joseph Lovering,	of Class I.
Benjamin Peirce,	
Benjamin A. Gould, Jr.	
John A. Lowell,	of Class II.
Louis Agassiz,	
John B. S. Jackson,	
James Walker,	of Class III.
Jared Sparks,	
Nathan Appleton,	

Professor Gray presented a paper entitled, "Caroli a Linné ad Bernardum de Jussieu ineditæ, et mutuæ Bernardi ad Linnæum Epistolæ; curante Adriano de Jussieu." Referred by the Publishing Committee.

The following Foreign Honorary Members were elected: —

In Class I. Section 2, Professor C. A. F. Peters, of Königsberg.

In Class III. Section 1, Professor C. Mittermaier of Heidelberg.

In Class III. Section 2, August Boeckh, of Berlin.

In Class III. Section 2, Professor R. Lepsius, of Berlin.

In Class III. Section 2, Chevalier Bunsen, Prussian Ambassador, London.

In Class III. Section 3, G. Grote, of England.

William Raymond Lee was elected a Fellow of the Academy, in the Section of Technology and Engineering.

On motion of Professor Agassiz, it was voted, that the next monthly meeting of the Academy be held on the third Tuesday of June, at half past 7 o'clock, P. M.

Three hundred and eighty-first meeting.

June 21, 1853. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from William Raymond Lee, Esq., accepting membership of the Academy; and a letter from the Hon. Timothy Walker, of Cincinnati, acknowledging the reception of the resolutions passed at the annual meeting of the Academy on the death of his brother, Sears C. Walker, Esq.

Professor Agassiz made a communication on the family of Cyprinodonts, of which he had discovered some new generic forms, and twelve new species, in a recent visit to the Southern States. The differences between the sexes are often so marked in this family of fishes, that the males and females have been described under distinct genera. At a former meeting he had mentioned an error of this kind, and he was now able to correct another. Pœcilia and Mollienisia, described as distinct genera by Cuvier and Valenciennes, he had ascertained to be the male and female of the same species, the former being the female and the latter the male. When young, both sexes look exactly alike. He had established a new genus, *Heterandria*, in which the sexual differences were very remarkable; the position and shape of the ventral and other fins being quite different, which he showed by diagrams. The habits of these fishes, living in immense numbers, crowded together in very shoal water, enabled him to explain a figure represented in the fifth volume, Plate 41, of his Fossil Fishes, in which the great number of individuals was remarkable; and the knowledge of the sexual differences renders unnecessary any hypothesis to account for supposed displacements of fins, or the occurrence together of different species. He also had established a new genus, *Zugonectes*, in which no sexual differences existed.

Dr. Burnett read a paper

" *On the Signification of Cell-segmentation, and the Relations of this Process to the Phenomena of Reproduction.*

" The phenomena of the segmentation of cells are intimately connected with many of the highest conditions of organization, and it becomes a question of no little interest in physiology, what interpretation is to be put upon this process of segmentation.

" By the term Cells, I include, not merely the elementary constituent particles of organized forms, but also ova, for it now appears pretty definitely settled that the ovum is, *morphologically*, only a cell; of this point, deducible from the observation of various naturalists upon the elementary condition of ova in different lower animals, I have recently satisfied myself, from investigations upon the ovaries of insects. Moreover, the segmentation of the ovum as preliminary to the formation of a new individual involves physical phenomena not in the least different from those of this process occurring with simple individual cells.

" This process consists, as is well known, in the successive halvings of the nucleus of a cell, the number of the parts produced being, therefore, whether greater or less, the multiple of *two* in a geometrical progression. Its physical conditions are, briefly, first, a sulcation of the cell membrane at one point; the concavity thus commenced gradually deepens and extends through the cell, ending in the complete halving of the cell, together with its contents; each of the halves thus formed undergoes the same process of division, and so on to a greater or less number of subdivisions, the products being, not segments of a sphere, as would be the case from the division of inorganic matter, but miniature cells, resembling, in every particular except mere size, the original cell. This spontaneous division and subdivision of organic matter, by which definite particles reproduce their kind, lies at the very foundation of the successive continuation of all specific organized forms in the vegetable and animal world.

"Until late years, this process of segmentation was supposed to belong exclusively to the impregnated ovum, and to be the index of its state of fecundation. Recent researches in histology, however, have shown, not only that it is a very common phenomenon with most individual cells, but also that it may occur in the ovum before fecundation; that is, is not the direct sequela of this last. In epithelial cells, as also those belonging to various morbid growths, I have watched this process occurring exactly as with the ovum; and in the ova of the common codfish (*Gadus morrhua*), before expelled from the ovaries, and therefore before impregnation, I have seen phenomena indicating that the segmentation of the vitellus had already commenced.

"But we will examine the details of this process as occurring where they are mostly completely expressed, in the impregnated egg. Throughout the entire organized world, the development of new individual forms from the ovum which has its origin in a proper sexual organ, is always preceded by this process, to a more or less complete extent; this segmentation may, indeed, go on to a certain extent before fecundation, as already remarked, but its continuance ending in the evolution of a new individual form is invariably dependent upon the act of fertilization by the male product, or sperm. I wish to insist upon this point in reference to some remark soon to be made. It may be said further, that not only is the whole individual formed out of the segmentation products, but at those points of the animal which contain tissues of the noblest function is always the most complete; such, for instance, is the case with the line of the nervous centres.

"The sperm-cell being the analogue of the ovum, these same phenomena, just described, are observed to precede the formation of the spermatic particle, and I can confidently affirm that no spermatic particle is produced without the occurrence of these preliminary processes.

"With such data, and which are, indeed, all we possess, we ask, What is the physiological signification of this fissurating process in cells?

"To this I would reply, that it seems to be simply an expression of a vitalizing act, — a means by which cell-particles are extended or reproduced on the one hand, and, on the other, by which crude materials of organized matter are kneaded or worked over for the formation of *tissue* in distinct individual beings.

"Thus with simple cells, with the unimpregnated ovum, and with the sperm-cell, this process occurs, leading to a mere reproduction or multiplication of the cells, and which may continue to a greater or less extent; while, on the other hand, with the impregnated ovum, these processes, although physically the same, are directed from the fecundating act towards a definite end, that is, the formation of *tissues* which compose a new being.

"In this connection, I may well allude to those anomalous phenomena, the successive reproduction of individuals without the aid of the male influence, as occurs with the Aphides. The general character of this form of multiplication of individuals is well known in science; but what I wish to insist upon now is, that these phenomena, as I have recently studied them, have nothing antagonistic to the doctrines of cells just advanced, for the so-called eggs of the viviparous Aphides, and which develop without the aid of the sperm, are, in my opinion, not true eggs, but are rather *buds*, and therefore development here occurs by a kind of *internal germination*. But this subject of the development of Aphides in its details, as I have recently enjoyed the opportunity to successfully study it, I intend to present at the next meeting.

"Cell segmentation, therefore, is a vital act of cells as organic particles, and is primary instead of secondary in the grand acts of true generation.

"This subject, important as it is in itself, has a wide physiological bearing. If such phenomena invariably attend the production of a new individual form from a true egg, can there be, as has recently been advanced by several physiologists, animals composed of only a single cell? To this question the answer would be in the negative; and such forms would seem to me no more worthy to be regarded as true animals, than would be the resultant products of segmented epithelial cells.

"On the very lowest confines of the animal kingdom there are, to be sure, myriads of such forms, and if, in the present state of science, they can consistently be called by any name, I should prefer that of *Zoöids*, or animal-like forms. They appear to me to be intermediate conditions of bodies, or a kind of stepping-stones, by means of which some future true animal is to reach its perfect form. Modern research in the class of Infusoria indicates that its component forms are of this kind, and therefore that this whole class is likely to be taken by the remaining classes of the Invertebrata, when more extended study shall have made us more familiar with their details. I would therefore insist that cell-processes, however closely interwoven they may be with the expressions of individual life, cannot be considered as constituting the ground-work of its definition. True individual animal life seems to involve a cycle of relations not implied in simple cells; in other words, these last must always lose their character as such, in a definite form which belongs to the individual. The true generative act involves conditions which are peculiar and quite distinct from any of the other physiological conditions of life; it must be regarded as resulting only from the conjugation of two opposite sexes, — a sexual process where the potential representatives of two individuals are united for the evolution of one germ. The germ-power thus produced may be extended and branched by budding, &c., but it can be formed only by the act of generation; and the multiplication of animals by the processes of fission or of germination is of no higher physiological character than the mere segmentation of cells, or the reproduction of lost parts in the lower animals."

Professor Agassiz observed, that there was only an *analogy* between the segmentation of simple cells and the segmentation of the ovum, and went on to show the difference of the phenomena presented in the two cases.

As to the egg-like bunches, mentioned by Dr. Burnett as found in the bodies of the Aphides, and considered by him as "buds," and not as true "eggs," Professor Agassiz could not agree with him. From the absence of peduncles, these free cells had not the first characteristic of buds, and he was inclined to consider them rather as true eggs. He mentioned the instance of turtles, in which there are three kinds of eggs in different stages of fecundation or growth, some to be laid this season, and others after a lapse of one or two years, which have received their fertilizing influence from the male this long period in advance. Speaking of the development of eggs, he alluded to the fact that in bees there are two kinds of females produced from eggs, which, in the beginning, present no differences; every female bee might become a queen if properly fed and cared for, but from want of the proper surrounding influences most of them become sterile. In some species of crabs, he had found also two kinds of females, fertile and sterile, though, unlike the bees, existing in about the same numbers.

Dr. B. A. Gould, Jr. made some remarks on the means of diminishing the personal equation, or the best method of getting rid of personal errors in transit observations made by different observers. He quoted M. Arago, from the *Comptes Rendus* for February 14, 1853, in which he claims priority for the method of employing the senses of sight and *touch* to diminish the personal equation, instead of sight and *hearing*, as usually employed; this method of tapping at the instant the star passed the threads of the instrument dates back to 1843.

Dr. Gould mentioned a similar method employed at Philadelphia, some time between 1828 and 1832. The best way, he believed, was that employed in our Coast Survey, by the electric clock, by breaking the circuit by a tap of the finger at the instant of the transit.

The problems, why sight and hearing should be less accurate than sight and touch, why observers should differ from each other, and why the same observer should differ from himself in the same manner of observation, are exceedingly difficult to solve; they involve the consideration of temperament, physiological conditions, state of the health, mechanical dexterity, &c., which make the subject exceedingly intricate.

Professor Bache, Professor Peirce, Professor Agassiz, and the President made remarks on the same subject.

Three hundred and eighty-second meeting.

August 10, 1853. — QUARTERLY MEETING.

The VICE-PRESIDENT in the chair.

The Corresponding Secretary read letters from Chevalier Bunsen and George Grote, Esq., acknowledging their election as Foreign Honorary Members of the Academy.

Dr. Gray called the attention of the Academy to the death of one of its Foreign Honorary Members, Adrien de Jussieu, of Paris, and made some remarks on the estimable character and eminent scientific services of this last representative of the illustrious line of the Jussieus.

Three hundred and eighty-third meeting.

September 28, 1853. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from August Boeckh and R. Lepsius, of Berlin, acknowledging their election as Foreign Honorary Members of the Academy.

Professor Joseph Winlock, of Kentucky, now resident in Cambridge, and Rev. Thomas Hill, of Waltham, were elected Fellows of the Academy in the Section of Mathematics.

Dr. B. A. Gould, Jr. communicated to the Academy the fact, that there exists an error in the formula given in the blanks for the reduction of transit observations; and that all the observations in this country, and also the Greenwich observations, are incorrect by the amount of this error, the maximum of which amounts to one third of a second of time.

Professor A. Gray laid before the Academy a paper entitled "Characters of some new Genera of Plants, mostly from Polynesia, in the Collection of the United States Exploring Expedition, under Captain Wilkes." (In continuation of those communicated May 4, 1852; Proceedings, Vol. II. p. 323.)

DICLIDOCARPUS, Nov. Gen. Tiliacearum.

Flores polygamo-dioici? Calyx 3-bracteolatus, 5-phyllus; sepalis

crassis æstivatione valvatis. Petala 5, inappendiculata, æstivatione imbricata. Discus hypogynus, annularis, crenatus. Stamina creberrima, discreta: antheræ biloculares. Ovarium sessile, oblongum, biloculare, pilis parcis circumdatum, stigmate sessili retuso coronatum, multiovulatum, fl. masc. effœtum sæpissime exovulatum. Capsula latissime obcordato-rhomboidea, bilocularis, dissepimento contrarie compressa, marginibus alata, ab apice loculicide bivalvis, polysperma. Semina lenticulari-globosa, hinc impressa, margine pilis prælongis crinita; testa fragili laxa. Embryo albumine carnoso vix brevior; cotyledonibus orbiculatis planis radicula æquilongis. — Arbor; foliis ovalibus integerrimis; stipulis caducis; floribus in cymulis axillaribus parvis.

DICLIDOCARPUS RICHII. — Feejee Islands.

DRAYTONIA, Nov. Gen. Ternstrœmiacearum.

Calyx ebracteolatus, 5-partitus, imæ basi ovarii tantum accretus, persistens; sepalis inæqualibus æstivatione imbricatis. Petala 5, obovata, æstivatione convoluta vel convoluto-imbricata. Stamina plurima; filamentis basi dilatatis breviter monadelphis: antheræ biloculares, dorso affixæ incumbentes, loculis apice rima introrsa hiantibus. Ovarium triloculare (rarius 4 – 5-loculare): stylus unicus: stigma obtuse trilobum. Ovula in placentis incrassatis, e loculorum angulo centrali prominentibus, plurima, anatropa. Capsula subcarnosa, trilocularis (rarius 4 – 5-locularis), apice loculicide trivalvis? loculis polyspermis. Semina reticulato-scrobiculata. Embryo in axi albuminis carnosi, eodem dimidio brevior, subcylindricus; cotyledonibus brevibus semiteretibus. — Arbuscula *Saurauja* facie et affinis; sed differt, stylis in unicum coalitis, ovario triloculari ima basi calycis connato, disco nullo.

DRAYTONIA RUBICUNDA. — Feejee Islands. The genus is dedicated to Mr. Joseph Drayton, the principal artist of the Expedition.

RHYTIDANDRA, Nov. Gen. Olacacearum.

Flores hermaphroditi. Calyx parvulus; tubo cum ovario connato; limbo cupulari truncato, margine 6 – 7-denticulato. Corollæ epigynæ petala 6–7, linearia, conniventia, æstivatione valvata. Stamina 6 – 7, petalis alterna, libera: filamenta brevissima, intus barbata: antheræ lineares, introrsum adnatæ, dithecæ, 4-locellatæ, locellis annulatorugosis vel cameratis. Discus epigynus scutelliformis. Ovarium inferum, uniloculare, uniovulatum; ovulo ex apice loculi parvi suspenso. Stylus elongatus, sulcatus, bifidus, lobis 2–3-dentatis; stigmatibus terminalibus parvis. (Fructus ignotus.) — Frutex sarmentosus; foliis ovatis obliquis; pedunculis axillaribus cymulam paucifloram gerentibus.

R. VITIENSIS. — Feejee Islands.

PELEA, Nov. Gen. Rutacearum.

Flores polygami. Calyx 4-partitus, æstivatione imbricatus, cito deciduus. Petala 4, æstivatione valvata, mox decidua. Stamina 8. Discus brevissimus, integer, seu 8-crenulatus. Ovarium 4-loculare, 4-lobum, sæpius umbilicatum: stylus centralis: stigma 4-lobum. Ovula in loculis gemina. Capsula 4-partita stellariformis (coccis divaricatis), loculicida; endocarpio chartaceo ab exocarpio coriaceo seu lignescente solubili. Semina in loculis sæpissime bina, ovoidea; testa nitente drupacea. Embryo intra albumen carnosum rectus; cotyledonibus ovalibus; radicula supera. — Arbores Sandwicenses inermæ, odoratæ; foliis simplicibus integerrimis oppositis seu verticillatis coriaceis punctatis venosissimis; floribus axillaribus. — Genus *Melicopi* et *Acronychiæ* affine, Deæ Hawaiensium *Pele* dicatum. — Species veræ Sandwicenses sex, septima dubia Samoensis.

1. P. CLUSIÆFOLIA. — Clusia sessilis, *Hook. & Arn.* non *Forst.*

2. P. AURICULÆFOLIA (sp. nov.): glabra; foliis ternis oblongo-spathulatis basi auriculatis sessilibus; floribus fasciculatis ad axillas foliorum delapsorum secus caulem virgatum brevissime pedicellatis; capsula quadripartita.

3. P. OBLONGIFOLIA (sp. nov.): foliis oppositis seu ovalibus petiolatis; pedunculis (fl. fert.) in axillis solitariis uni–bifloris petiolum adæquantibus; capsula quadriloba, coccis subcarinatis.

4. P. ROTUNDIFOLIA (sp. nov.): foliis orbiculatis sessilibus valde reticulatis; floribus cymulosis; calycis lobis ovatis petala subæquantibus; stylo ovario puberulo breviore.

5. P. SANDWICENSIS. — Brunellia Sandwicensis, *Gaud. Bot. Freyc.*

6. P. VOLCANICA (sp. nov.): ramis junioribus petiolis et inflorescentia cymuloso-paniculata hirsuto-tomentosis; foliis oppositis ovalibus longe petiolatis majusculis glabratis; calycis lobis ovatis petalis plus dimidio brevioribus; stylo gracili ovario tomentoso æquilongo; capsula (sesquipollicari) glabra quadriloba, coccis recurvis carinatis.

7. P.? LUCIDA (sp. nov.): glaberrima; foliis oppositis ovalibus seu ovali-oblongis subcoriaceis supra lucidis creberrime penninerviis; cymis longe pedunculatis multifloris; ovariis fere discretis.

AMARORIA, Nov. Gen. Simarubacearum.

Flores monoici vel dioici. *Masc.* Sepala 6. Petala nulla. Stamina 6, petalis opposita: antheræ subsessiles. Discus carnosus, profunde trifidus, lobis bifidis. *Fœm.* Sepala 4–5, parva, persistens. Petala 4–5, linearia, carinata, reflexo-patentia. Rudimenta staminum petalis numero dupla, minima, sub disco incrassato 8–10-crenato inserta. Ovarium simplex, ovoideum, uniloculare, uniovulatum, vertice stigmate sessili maximo depresso reniformi crasso obtectum. Ovulum sub apice loculi appensum subanatropum. Drupa sicca, nuciformis, ovoidea, subcompressa; epicarpio tenui; putamine osseo. Semen amphitropum, exalbuminosum. Cotyledones ovales, planæ; radicula brevissima supera. — Arbuscula *Soulameæ amaræ* facie et affinis.

AMARORIA SOULAMEOIDES. — Feejee Islands.

BRACKENRIDGEA, Nov. Gen. Ochnacearum.

Calyx persistens. Antheræ læves, longitudinaliter dehiscentes. Stigma leviter quinquelobum. Ovulum circa processum e fundo ovarii assurgentem curvatum, hippocrepicum. Semen angustum, circinnatum. Embryo semini conformis, gracilis; cotyledonibus anguste linearibus; radicula centripeto-infera. Flores umbellato-fasciculati. — Cætera *Gomphiæ*.

1. B. NITIDA, sp. nov. — Feejee Islands.

2.? B. HOOKERI. — Gomphia Hookeri, *Planch.* — Penang.

The genus is dedicated to the zealous Assistant Botanist of the Expedition, Mr. William D. Brackenridge.

ONCOCARPUS, Nov. Gen. Anacardiacearum.

Flores dioici. Calyx cupularis, 5-dentatus. Petala 5, hypogyna, oblonga, æstivatione valvata. *Masc.* Stamina 5. Gynæcium nullum. *Fœm.* Stamina nulla? Ovarium pyramidatum, basi 5-lobum, stigmate sessili truncato terminatum, uniloculare. Drupa depressa, difformis, torosa vel lobata, toro incrassato carnoso obconico insidens;

putamine osseo sinuoso-multilobato uniloculari monospermo. Semen exalbuminosum, loculo sinuoso conforme; testa tenui. Embryo transversus; cotyledonibus carnosis lobatis; radicula brevissima. — Arbor venenosa, simplicifolia, *Semecarpi* facie et inflorescentia.

Oncocarpus Vitiensis. — Feejee Islands.

STREPTODESMIA, Nov. Gen. Legum. Hedysarearum.

Calyx persistens, quinquenervis, quinquefidus; tubo campanulato; laciniis subæqualibus. Corolla *Adesmiæ*, sed emarcida persistens. Stamina 10, libera. Ovarium 4–6-ovulatum: stylus filiformis, adscendens. Lomentum corolla marcescente inclusum, sutura carinali excisum 3–6-articulatum; articulis subglobosis, a sutura vexillari continua filiformi stylifera spiraliter contorta persistente secedentibus, bivalvibus, monospermis, valvulis lævibus membranaceis. Semina subglobosa. — Suffrutex intricato-ramosissimus, canescens; ramulis spinescentibus; foliis abrupte pinnatis paucijugis; racemis paniculatis brevibus, rhachi spinescente persistente; corolla lutea.

Streptodesmia canescens. — Rio Negro, North Patagonia.

LUMA, Nov. Gen. Myrtacearum.

Calycis tubus turbinatus vel globosus; limbus 4- (rarissime 5-) partitus; lobis æstivatione imbricatis. Petala, stamina, etc. *Eumyrti.* Ovarium 3- (raro 2-) loculare; placentis multiovulatis. Bacca 2–3-locularis (dissepimentis sæpe evanidis) oligo-pleiosperma. Semina compressa, reniformi-rotundata; testa membranacea, libera. Embryo curvatus: radicula longa: cotyledones sat magnæ, ovales, subcarnosæ, fere planæ, radiculæ accumbentes, seu foliaceæ et contortuplicatæ. — Frutices vel arbores Chilenses, fragrantes; foliis coriaceis; pedunculis axillaribus uni-plurifloris; petalis albis.

1. L. Cheken. — Myrtus Cheken, *Feuillée*, *Spreng.* M. Luma, *Molina.* Eugenia Cheken, *Hook. & Arn.* E. apiculata & E. Gilliesii, *Hook. & Arn.* E. affinis, *Gillies.*
2. L. Temu. — Eugenia Temu & E. multiflora, *Hook. & Arn.*
3. L. Cruckshanksii. — Eugenia Cruckshanksii, *Hook. & Arn.*
4. L. stenophylla. — Eugenia stenophylla, *Hook. & Arn.*
5. L. obtusa. — Eugenia obtusa, *DC.* Myrtus Raran, *Colla.*

6. L. FERRUGINEA. — Eugenia ferruginea, *Hook. & Arn.*

7. L. CORREÆFOLIA. —Eugenia correæfolia, *Hook. & Arn.*

To the genus doubtless belong Eugenia leptospermoides, *DC.* E. planipes, *Hook. & Arn.* E. Gayana, *Barneoud.* E. Bridgesii, *Hook. & Arn.* Myrtus multiflora, *Juss.*; *DC.*, etc.

ASTRONIDIUM, Nov. Gen. Melastomacearum.

Flores tetrameri. Petala 4. Stamina 8: antheræ oblongo-lineares; connectivo augusto basi calcarato. Stigma minutum simplicissimum. Placentæ 3 – 4, e fundo loculorum exortæ. — Cætera *Astroniæ.*

ASTRONIDIUM PARVIFLORUM. — Feejee Islands.

PLEIOCHITON, Naudin, Mss. Nov. Gen. Melastomacearum.

Flores pentameri, involucrati. Involucrum generale 3 – 4-phyllum, singuli floris 2 – 3-phyllum. Calycis tubus turbinatus: dentes 5, duplicati; exteriores subulati, cum interioribus brevioribus membranaceis obtusissimis inferne connati. Petala 5, ovata, acuta. Stamina 10, æqualia: antheræ lineari-subulatæ, apice subrecurvæ poro unico tenuissimo apertæ; connectivo exappendiculato. Stylus filiformis: stigma acutum. Ovarium ovoideum, liberum, apice verticillo setarum coronatum, 4 – 5-loculare. Placentæ axiles. — Frutex vel arbor fere glabra; ramis validis ad nodos setoso-hispidis; foliis ovalibus crasse coriaceis; inflorescentia terminali; floribus cum bracteis foliaceis involucrantibus capitato-congestis.

PLEIOCHITON CRASSIFOLIA, Naudin, Mss. — Organ Mountains, Brazil?

HAPLOPETALON, Nov. Gen. Legnotidearum.

Calyx profunde quadrifidus; lobis triangulatis æstivatione valvatis. Petala 4, obovata, calyce inserta, fere exunguiculata, integerrima, carinata, æstivatione involuta, decidua. Stamina 16 – 20, brevissima, uniserialia, margini disci perigyni tenuis inserta: antheræ ovales, filamentis subulatis æquilongæ. Stylus brevis, apice 4 – 5-fidus; lobis linearibus patentibus apice stigmatosis. Ovarium depressum, calycis tubo (mediante disci) semiadnatum, uniloculare. Ovula 8, raro 10, e columna centrali geminatim appensa. — Frutex Vitiensis; foliis *Carallicæ;* stipulis interpetiolaribus caducis; pedicellis in axillis laxe fasciculatis. (Genus *Gynotrochi*, *Cassipoureæ*, *Carallicæ*, et *Crossostyli* Forst. (certissime inter Legnotideas collocandæ!) affine, sed tetramerum, polyandrum, petalis integerrimis.)

HAPLOPETALON RICHII. — Feejee Islands.

SICYOS, Linn., subgen. SICYOCARYA.

Fructus ovato-pyramidatus vel oblongus, 4 – 6-angulatus (rarissime triqueter), inermis, pl. m. rostratus; pericarpio incrassato. Antheræ 2 – 5, sinuosæ, basi connatæ; connectivo angusto.

1. SICYOS PACHYCARPUS, *Hook. & Arn.* — Sandwich Islands.

2. SICYOS MACROPHYLLUS (sp. nov.): foliis magnis cordato-rotundis 3 – 5-lobatis argute denticulatis subtus puberulis; paniculis masculis umbellato-compositis longe pedunculatis; pedicellis filiformibus; fructu ovato 5 – 6-angulato glabrato rostrato. — Hawaii, Sandwich Islands.

3. SICYOS CUCUMERINUS (sp. nov.): glaber; foliis late cordatis integris denticulatis; paniculis masculis breviter pedunculatis sæpe trifidis racemosis; fructu oblongo 5 – 6-angulato glaberrimo. — Var. β. foliis triangulato-cordatis promisse acuminatis. — Var. γ. foliis pedatilobis. — Hawaii, Sandwich Islands.

SICYOS, subgen. SICYOPSIS.

Fructus obovatus, turgidus, inermis, hirsutus, infra apicem obtusissimum dentibus calycinis subulatis deflexis coronatus; pericarpio baccato. Columna staminum apice trifida. Antheræ 3 liberæ, vel 5 triadelphæ; connectivo dilatato plano utrinque emarginato.

SICYOS MONTANUS, Pœpp. & Endl. — Peru.

Three hundred and eighty-fourth meeting.

October 11, 1853. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

The report of a committee on social meetings of the Academy was taken from the table, and, after some remarks of Messrs. Emerson, Gould, Gray, and the President, adopted. A committee, consisting of Messrs. C. Jackson, Jr., Dr. Cabot, and Dr. H. I. Bowditch, was appointed to make the necessary arrangements.

Dr. W. I. Burnett read a memoir entitled "Researches on the Development of the Aphides," of which the following is an abstract: —

"My observations were made upon *Aphis caryæ* (probably *Lachnus* of Illiger, or *Cinara* of Curtis), one of the largest and most favorable species for these investigations. This was the spring of 1853. The first colony, on their appearance from their winter quarters, were of mature size, and contained, in their interior, the developing forms of the second colony quite far advanced in formation. On this account it was the embryology of the third series or colony that I was able to first trace. A few days after the appearance of the first colony (A), the second colony (B), still within the former, had reached two thirds of their full embryonic size; the arches of the segments had begun to close on the dorsal surface, and the various appendages of the embryo were becoming prominent; the alimentary canal was more or less completely formed, although distinct abdominal organs of any kind belonging to the digestive system were not apparent.

"At this time, and while the individuals B were not only in the abdomen of their parents A, but were also inclosed each in its primitive egg-like capsule, — at this time, I repeat, appeared the first traces of the germs of the third colony, C. Their first traces consisted of small egg-like bodies, arranged two, three, or four in a row, and attached at the locality where are situated the ovaries in the oviparous forms of the Aphididæ. These egg-like bodies were either single nucleated cells of one three-thousandth of an inch in diameter, or a small number of such cells inclosed in a simple sac. These are the germs of the third generation or colony, and they increase *pari passu* with the development of the embryo in which they are formed, and this increase of size takes place, not by the segmentation of the primitive cells, but by the endogenous formation of new cells within the sac. After this increase has continued for a certain time, these bodies appear like little oval bags of cells, — all the component cells being of the same size and shape, — there being no one particular cell which is larger and more prominent than the others, and which could be comparable to a germinative vesicle. While these germs are thus constituted, the formation of new ones is continually taking place. This occurs by a kind of constriction process of the first germs; one of the ends of these last being pinched off, as it were, and so what was before a single body or sac becoming two, which are attached in a moniliform manner. The new germs thus formed may consist each of a single cell only, as I have often seen; but they soon attain a more uniform size by the endogenous formation of new cells within the sac in which it is inclosed. In this way the germs are multiplied to a considerable number, the nutritive material for their growth being apparently a fatty liquid, in which they are bathed, contained in the abdomen, and which is thence derived from the abdomen of the first parent. When these germs have reached the size of about one three-hundredth of an inch in diameter, there appears on each, near the inner pole, a yellowish, vitellus-looking mass or spot, composed of yellowish cells, which, in size and general aspect, are different from those constituting the germ proper. This yellow mass increases after this period, *pari passu* with the germ, and at last lies like a cloud over and partially concealing one of its poles. I would, moreover, insist upon the point, that it does not gradually extend itself over the whole germ-mass, and is, therefore, quite unlike a proligerous disc.

"When these egg-like germs have attained the size of a one-hundred-and-fiftieth of an inch in diameter, there begins to appear distinctly the sketching or marking out of the future embryo. This sketching consists at first of delicately marked retreatings of the cells here and there; but these last soon become more prominent from sulcations, and at last the form of an articulated embryo is quite prominent.

"During this time, the yellowish, vitellus-looking mass has not changed its place, and, although it is somewhat increased in size, yet it appears otherwise the same. When the development has proceeded a little further, and the embryo has assumed a pretty definite form, the arches of the segments, which have hitherto remained gapingly open, appear to close together on the dorsal surface, thereby inclosing the vitellus-looking mass within the abdominal cavity. It is this same vitelloid mass thus inclosed, which furnishes the development of the new germs (which in this case would be those of the fourth colony, or D), and this germ development here commences with the closing up of the abdominal cavity, and then the same processes we have just described are repeated.

"The details of the development subsequent to this time, the formation of the different systems of organs, &c., are precisely like those of the development of true oviparous Arthropoda in general; and although the ovoid germ has at no time the structural peculiarities of a true ovum, — such as a real vitellus, germinative vesicle, and dot, — yet if we allow a little latitude in our comparison, and regard the vitellus-looking mass as the *mucous*, and the germ-mass proper as the *serous* fold of the germinating tissue, as in true ova; — if this comparison of parts can be admitted, then the analogy of the secondary phases of development between these forms and true ova of the Arthropoda can be traced to a considerable extent.

"These secondary phases of development need not here be detailed, for they correspond to those described by Herold and Kölliker, of the true ovum in other Insecta, and which, too, I have often traced in various species of the Arthropoda in general.

"When the embryo is fully formed and ready to burst from its capsule in which it has been developed, it is about one sixteenth of an inch in length, or more than eight times the size of the germ, when the first traces of development in it were seen. From this last-mentioned fact, it is evident that, even admitting that these germ-masses are true eggs, the conditions of development are quite different from those of the eggs of the truly viviparous animals, for in these last the egg is merely hatched in the body instead of out of it, and, moreover, it is formed exactly as though it was to be deposited, and its vitellus contains all the nutritive material required for the development of the embryo until hatched. With the Aphididæ, on the other hand, the developing germ derives its nutritive material from the fatty liquid in which it is bathed, and which fills the abdomen of the parent. The conditions of development in this respect are here, therefore, more like those of the Mammalia, and the whole parent animal may be regarded in one sense as an individualized uterus filled with germs; for the digestive canal with its appendages seems to serve only as a kind of laboratory for the conversion of the succulent liquids this animal extracts from the tree on which it lives, into this fatty liquid which is the nutritive material of the germs.

"Omitting the curious and interesting details of the further history of the economy of these Insecta, as irrelevant to the point in discussion, we will now turn to see what view we should take of these processes, and what is their physiological interpretation. In the first place, it is evident that the germs which develop these viviparous Aphides are not true eggs; they have none of the structural characteristics of these last, — such as a vitellus, a germinative vesicle, and dot; on the other hand, they are at first simple collections, in oval masses, of nucleated cells. Then, again, they receive no special fecundating power from the male, which is the necessary preliminary condition of all true eggs; and furthermore, the appearance of the new individual is not preceded by the phenomena of segmentation, as is also the case with all true eggs. Therefore, their primitive formation, their development, and the preparatory changes they undergo for the evolution of the new individual, are all different from those of real ova.

"Another point of equal importance is, these viviparous individuals of the Aphides have no proper ovaries and oviducts. Distinct organs of this kind I have never been able to make out. The germs, as we have before seen, are situated in moniliform rows, like the successive joints of confervoid plants, and are not inclosed in a special tube. These rows of germs commence each from a single germ-mass, which sprouts from the inner surface of the animal, and increases in length and the number of its component parts by the successive formation of new germs by the constriction process as already described. Moreover, these rows of germs, which, at one period, closely resemble in general form the ovaries of some true Insecta, are not continuous with any uterine or other female organ, and therefore do not at all communicate with the external world; on the other hand, they are simply attached to the inner surface of the animal, and their component germs are detached into the abdominal cavity as fast as they are developed, and thence escape outwards through a *porus genitalis*.

"With these data, the question arises, What is the proper interpretation to be put upon these reproductive phenomena we have just described? My answer would be, that the whole constitutes only a rather anomalous form of gemmiparity: as already shown, the viviparous Aphididæ are sexless; they are not females, for they have no female organs, they are simply *gemmiparous*, and the budding is internal, instead of external, as with the Polypi and Acalephæ; moreover, this budding takes on some of the morphological peculiarities of oviparity, but these peculiarities are economical and extrinsic, and do not touch the intrinsic nature of the processes therein concerned. Viewed in this way, the different broods or colonies of Aphididæ cannot be said to constitute as many true generations, any more than the different branches of a tree can be said to constitute as many trees; on the other hand, the whole suit, from the first to the last, constitute but a single true generation. I would insist upon this point as illustrative of the distinction to be drawn between *sexual* and *gemmiparous* reproduction. Morphologically, these two forms of reproduction have, it is true, many points of close resemblance, but there is a grand physiological difference, the perception of which is deeply connected with our highest appreciation of individual animal life.

"A true generation must be regarded as resulting only from the conjugation of two opposite sexes, — from a sexual process in which the potential representatives (spermatic particle and ovum) of two opposite sexes are united for the elimination of one germ. The germ power thus formed may be extended by gemmation or fission; but it can be formed only by the act of generation, and its play of extension by budding or by division must always be within a certain cycle, which cycle is recommenced by the new act of the conjugation again of the two sexes. In this way the dignity of the ovum as the primordium of all true individuality is maintained.

"In the memoir from which this is an extract, I have entered into a full discussion of those many points suggested by these studies. One of these is the relation of this subject to some of the various doctrines of development, which have been advanced in late years, such as that of *Alternation of Generation* by Steenstrup, and that of *Parthenogenesis* by Owen. I have there attempted to show that the phenomena of these doctrines, as advanced by their respective advocates, all belong to those of gemmiparity, and that therefore Alternation of Generation and Parthenogenesis, in their implied sense, are misnomers in physiology. Another point there treated *in extenso* is the identity of this mode of reproduction we have just described in the Aphididæ with that observed in the so-called hibernating eggs of the Entomostraca, and the like phenomena observed in nearly every class of the Invertebrata. They are all referable, in my opinion, to the conditions of gemmation, modified in each particular case, perhaps by the economical relations of the animal."

Dr. Samuel Parkman and Dr. Benjamin E. Cotting were elected Fellows of the Academy in the Section of Medicine and Surgery.

Three hundred and eighty-fifth meeting.

October 12, 1853. — SPECIAL MEETING.

The PRESIDENT, and afterwards Professor Parsons, in the chair.

The President stated that this meeting of the Academy, in committee of the whole, was called for the special purpose of acting upon the reports made by committees on the revision of the Statutes of the Academy.

Three hundred and eighty-sixth meeting.

November 8, 1853. — MONTHLY MEETING.

The Academy met by invitation at the house of the President, — Dr. George Hayward, and afterwards the President, in the chair.

A letter was read from the Academy of Archæology of Belgium, at Antwerp, presenting the seventh volume of their Annals, requesting an exchange of publications, and a mutual election of Corresponding Members.

Professor J. Wyman made some further observations on the effect of low temperature and darkness in arresting the development of tadpoles. The experiment, at the time of his first observations, had lasted for about seventeen months; now, at the end of two years, some specimens are living in the same condition, showing no disposition to undergo metamorphosis.

Dr. Hayward related the case of a boy who had recently died from perfectly marked hydrophobia, commencing just thirty days after the bite of the dog. The wound, which was near the angle of the eye, was thoroughly cleansed by suction and cauterized with nitrate of silver, and in a few days seemed quite well; pain in the wound came on after a month; the boy became irritable, and much disturbed by cold air and water; attempts to swallow produced convulsions; stupidity soon came on, and death took place apparently from effusion in the brain. This disease is perfectly distinct from tetanus. In tetanus, the mind is unaffected, and deglutition is perfect except during the paroxysms; the special nerves are the seat of the disease, and death ensues from asphyxia. In hydrophobia, not only the spinal nerves, but the medulla oblongata and the brain are affected. There are many cases of hydrophobia reported, but genuine cases are quite rare.

Dr. A. A. Gould mentioned the cases of a family of "bleeders," in which this idiosyncrasy of profuse and uncontrollable hemorrhage from trifling wounds was hereditary for four generations. The cases had come under his own observation. Every one of the males was a bleeder, but not one of the females. There was also the usually observed tendency to rheumatic pains in these individuals.

Dr. Burnett read a paper on the "Intimate Structure of Muscle," in which he combated Martin Barry's idea, that animal fibre is composed of twin spiral filaments. He considered the spiral arrangement as an accident, and not an essential character; he exhibited specimens under the microscope in confirmation of his views.

Professor Wyman observed that the same course of development mentioned by Dr. Burnett as occurring in the formation of muscular fibre, or cells arranging themselves in linear series, then forming fibrillæ and striæ, he had noticed in the scale of animal life; as you ascend from the Polyp, where there is nothing but cells, to the higher forms of life, the linear arrangement, the fibrillæ, and the striæ successively make their appearance in the muscular structure.

Dr. Storer alluded to the sudden death of J. E. Teschemacher, Esq., a Fellow of the Academy, and spoke in the highest terms of his attainments in natural science, especially mineralogy, geology, and botany; and of the qualities which made him in every respect a most estimable man.

D. A. A. Gould observed, that, in addition to his purely scientific attainments, Mr. Teschemacher was an excellent linguist, and eminent for his knowledge of horticulture and agriculture. His latest investigations had been to ascertain from what kind of plants coal has been formed; his collection of specimens illustrating this point was astonishingly large and rich, and his death will be a very great loss to this little cultivated and little known branch of natural science.

Three hundred and eighty-seventh meeting.

November 9, 1853. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from Professor Mittermaier, of Heidelberg, acknowledging his election as Foreign Honorary Member of the Academy; also letters from Rev. Thomas Hill, Dr. S. Parkman, and Dr. B. E. Cotting, severally acknowledging their election as Fellows of the Academy.

On motion of Professor Peirce, it was

"*Voted*, That the Academy hold meetings for scientific discussion on the last Tuesday of every month, at their Hall."

Dr. B. A. Gould, Jr. announced, that a complete catalogue of the books and pamphlets in the Academy's library had been made by the Recording Secretary, and reported sundry regulations made by the Committee on the Library for the circulation, return, and safe-keeping of the books.

Mr. B. A. Gould alluded to the recent death of M. Arago, a Foreign Honorary Member of the Academy, and offered the following preamble and resolutions: —

"Whereas, when men who have conferred benefits upon their race, or extended the domain of science, are removed from the world, it is but fitting that those who appreciate their services, and especially public bodies, should join in doing honor to their memory, —

"*Resolved*, That the Academy has received information of the decease of its illustrious member, Arago, with a profound sense of the loss sustained by science and by humanity, and desires thus to express its sentiments of respect for the memory of the distinguished scientific investigator and philanthropist.

"*Resolved*, That a copy of these resolutions be transmitted to the family of the deceased."

The resolutions were unanimously adopted.

Professor Agassiz made a verbal communication on some new species of cartilaginous fishes which he had discovered on the coast of the United States, which were especially interesting for the study of the relations existing between fossil and living types. America contrasts strongly with Europe in the number of living species belonging to genera of animals which also exist in a fossil state; the old types are so much more numerous here, that this continent to the paleontologist has quite an old-fashioned appearance.

The Port Jackson Shark is the only type of its family now represented by a living species in the Old World. He had found on our coast eight genera of cartilaginous fishes not noticed before. The genus *Carcharias* is not found fossil, and the living species are few. The genus *Odontaspis*, found fossil as low as the chalk, has two representatives on our coast, one in Long Island Sound, the other on the coast of South Carolina; to this genus he thinks the *Squalus macrodon* of Mitchell belongs. To this genus, also, belong most of the fossil teeth of our tertiary deposits; many of these, previously considered as belonging to the genus *Lamna*, he was now, from examination of living representatives, able to refer to their true genus, *Odontaspis*. The old genus *Lamna* he had divided into *Lamna* and his genus *Oxyrhina*. Of the genus *Galeocerdo*, geologically very important, with teeth serrated and curved backwards, he had obtained a species as far south as South Carolina. Fossils of this genus are found in deposits as early as the cretaceous; the genus *Galeus* differs in the serrations of its teeth. The large teeth found at Gay Head and Marshfield belong to the genus *Carcharodon*. Dr. Andrew Smith found a representative of this genus at the Cape of Good Hope. Professor Agassiz had received a jaw of a living species from Nantucket, and some teeth from Cape Cod, belonging to this genus. This, then, is another of the old types found on our coast. It differs generically from *Carcharias*; the differences do not depend so much on the position of the teeth in the jaw, as on the structure of the teeth, which are hollow in *Carcharias* and full in *Carcharodon*, though a careful comparison will reduce the number of established species of fossil Carcharodons. He had also discovered new genera of *Scates*. Of the three fossil genera, *Myliobates*, *Zygobates*, and *Aëtobates*, the first is found living in the Old World, while the second and third are unknown there, except as fossils; all these genera have been found living in North and South America. Of the genus *Raia*, of which there are vast numbers in Europe, the number is diminished in America by at least one third.

Professor Peirce made a communication on a new view of the fundamental principles of Analytic Mechanics.

Three hundred and eighty-eighth meeting.

November 17, 1853. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

The time of this meeting was occupied in the transaction of business.

A communication was received from Mr. C. O'Brian, requesting permission to publish in a scientific periodical, about to be established in Cambridge, the proceedings of the Academy. The communication was referred to the Committee of Publication.

Three hundred and eighty-ninth meeting.

November 29, 1853. — SECOND NOVEMBER MEETING.

DR. CHARLES BECK in the chair.

Dr. Burnett made a communication on the development of organs, especially of those of glandular structure; in which he traced the progress from a mass of cells, arranging themselves in linear series, through the various stages of lateral saccations or diverticula, and the dichotomous ramifications dividing and subdividing to form the intricate structure of the organs. For instance, the ureter, first formed, undergoes this multiplied ramification till it forms the glandular structure of the kidney. This arborescent character of organic development, homologous perhaps with the branching of polyps, reduces the process of development to an extremely simple formula.

Professor Agassiz observed that the heart, which he had studied especially in fishes, makes its first appearance as a mass of apparently homogeneous cells; the interior cells gradually soften, forming a cavity, the walls being at the same time proportionally solidified. He did not perceive the homology of the ramification described by Dr. Burnett to the branching of polyps; the buds of a polyp are not hernial sacs communicating primarily with the parent stem, but solid tubercles formed on the outside, gradually becoming hollow and communicating only secondarily with the main trunk.

Professor J. Wyman asked if, in the development of the liver, the cells were first formed, and the tubes extended from the intestine to meet them, as Bischoff maintains. Dr. Burnett had made no observations on this point in the vertebrated animals.

Professor Agassiz made a communication on a new living species of *Cestracion* from China, and on some fossil teeth of sharks of this family which he had received from the carboniferous formation of Indiana. From the examination of these specimens he thinks that all the genera but one — which he made long ago from the scanty materials in Europe (only a single jaw and some dried skins) — will stand; of the species he is not so confident.

The new species, from its distinct bands, he would call *Cestracion zebra*. It is thus characterized: a square-shaped head resembling that of *Ostracion;* the nostrils open into the mouth by a strong fissure; the mouth is small, more anterior than usual; there are singular cheek-like projections on the sides of the head; the body is massive, and much elevated on the back; the dorsal fins much falcated, especially the second; the gill fissures are usually in advance of the pectorals, but in this species the pectorals begin anteriorly under the third gill-fissure; the spiracles open below the eyes; the caudal fin has its lower division two-lobed, the lower lobe looking like a second anal fin. The specimen, which he thought full-grown, was about one foot and a half long. The teeth in front differ much from those on the sides and back of the mouth; they are quite small in front, gradually becoming larger, and then again smaller; the anterior teeth are trilobed; the lobes gradually diminish backwards, become flat, and then rounded on their upper surface; there is a ridge on the median line, the remains of the three cusps. In the New Holland species, the front teeth have the median cusp much the longest, the back teeth being much the broadest.

Professor Agassiz compared these teeth with the fossil teeth he had received from Indiana. The teeth of the genus *Psammodus* resemble the back teeth of *Cestracion*, and are marked by numerous minute points; those of the genus *Strophodus* resemble *Cestracion*, having also a central prominence; in the genus *Ozodus*, the teeth are undulated, like the second form in *Cestracion*, but with lines radiating from each of the three cusps; in the genus *Helodus* (perhaps to be suppressed) the teeth have a prominent tubercle, like the anterior teeth of *Psammodus;* another reason for suppressing the former genus is that it is always found with the latter; in the genus *Petalodus* the teeth are much compressed and spreading, with a narrow root.

These are the same genera as are found in Europe; the specific identity he had not as yet determined. Other European sharks having no living representatives are also found here. The genus *Ctenoptychius*, the whole margin of whose teeth is serrated; the genus *Hybodus*, with cylindrical teeth, longitudinally striated, like those of Saurians, from the folds of the enamel; the genus *Dendrocladus*, having large dorsal spines, sometimes two feet long, which are always found with the teeth. Speaking of the gigantic species which must have borne these spines, he remarked that it was neither the first nor the last created members of any class in the animal kingdom which were the giants of that class; but rather those created at the middle epochs.

Professor Peirce made a communication, illustrated by diagrams, on the "collision of solid bodies." He believed that the speculations hitherto brought forward were radically defective, and comparatively useless; the collision of atoms only had hitherto been considered, instead of combinations of atoms.

Three hundred and ninetieth meeting.

December 13, 1853. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary announced a valuable bequest of books on the Infusoria, from the late Thomas Cole, Esq., of Salem, a Fellow of the Academy, consisting of Ehrenberg's great work, Kütsing's Phycologia, Müller's Animalcula Infusoria, Johnston's Zoöphytes, and Recherches Chimiques et Microscopiques sur les Conferves, Bisses, Tremelles, etc., avec 36 Planches, par Girod-Chantrans (4to, Paris, 1802).

On motion of President Walker, the following resolutions were unanimously adopted: —

"*Voted*, That the American Academy feel very sensibly the kind remembrance of their lamented associate, Mr. Cole, in the valuable legacy now received, and would express their sincere thanks to Mrs. Cole for the delicate generosity with which she has invested the expressed intentions of her lamented husband with the authority of a bequest.

"*Voted*, That the Librarian be directed to affix to the volumes now presented a statement that they are a bequest from their late associate, Mr. Thomas Cole."

Professor Lovering made a verbal report on the letter of Mr. C. O'Brian, requesting an abstract of the Academy's proceedings, which had been referred to the Publishing Committee. He did not see any objection to furnishing such an abstract, thereby expressing the willingness of the Academy to grant the request, without implying any sanction or recommendation of the journal he was about to establish. It was

"*Voted*, That the Secretary be allowed to furnish to Mr. O'Brian such portions of the records of the Academy as he may think proper."

Dr. J. Wyman exhibited the lower jaw of a mastodon from South America, brought from Chili by Lieutenant Gilliss. This animal ranged the whole of the continent, from 5° north latitude to 40° south. It has been found at great elevations in 34° south, at the height of 1,400 feet above the level of the sea; in Quito, Humboldt found it at the height of 7,200 feet; Mr. Darwin says it has appeared on the limits of perpetual snow. In these cases the land has been elevated since the deposition of the remains.

The number of species found here is doubtful; Cuvier made three, *M. augustidens*, *M. Humboldtii*, and *M. Andium*, of the last two one being small and the other large. De Blainville maintained that there was only a single species. It is not reasonable that *M. augustidens* should be found here; from the figures given by Falconer and others, Dr. Wyman thinks there are two species; all the teeth found are referable to two sizes, one about six inches and a half long, the other from nine to ten inches. The jaw he exhibited confirmed the view that there are two species, one of which is of small size; it was of small size, yet was that of an adult animal, as shown by the sixth molar. He had also another tooth differing so much from the others that perhaps a third species might be made out. It would not be strange if two species were found here, as in India, according to Falconer, eight or ten species are found in a limited district.

Dr. C. T. Jackson exhibited a branch of the Mistletoe, with the flowers, obtained from an oak-tree of North Carolina.

Dr. C. T. Jackson gave some account of the copper and gold mines of North Carolina; some of the copper mines are old gold mines which were worked till they became unprofitable from the presence of water; now, improved machinery permits them to be worked with profit. The principal copper ores are the yellow and gray sulphurets.

He described in some detail the coal region on Deep River, North Carolina; the coal is very bituminous, containing little sulphur, and is excellent for the manufacture of gas. He thinks there is a true coal basin; the strata dip down at an angle of 20°, then become horizontal, and, as he believes, rise again at about the same angle. He is inclined to think this a portion of the Lias or Oolitic group. Many scales of ganoid fishes, fish and Saurian coprolites, and minute fossil shells, resembling Cypris, are found in great abundance. The plants are not numerous, except in the grindstone grit under the coal; they resemble the plants of the Lias of Europe. Some bones, said to be Saurian, and perhaps Chelonian, have been found.

Professor W. B. Rogers remarked, that the age of the Deep River coal is probably the same as that of Eastern Virginia. The lithological characters are the same; the fossil plants, shells, and fish found are the same in the two regions. The topographical relations of the two regions are also the same. He does not believe that there is a coal basin at Deep River, but merely layers one over the other, all dipping at the same angle, running down and thinning out against the rocks below: he doubts if any great amount of coal exists there. On a recent visit to the new red sandstone of Virginia, he found the same fossils as in the coal measures, and the same in the new red sandstone of Pennsylvania. He concludes that all these formations are very nearly of the same age, more recent than is generally supposed, and that they belong to the Lias formation.

Dr. Jackson was not certain of the existence of a true coal basin there, though he thought there was as much evidence of it as is generally found; he had not, however, observed the dip at the other extremity of the basin corresponding in angle with that at Deep River.

Professor Agassiz remarked, that the age of this deposit was very interesting to him; the fishes did not agree either with those of the Trias of Southern Germany or the Lias of England, but seemed intermediate between the two; he was inclined to think that the new red sandstone of this country belonged to a group intermediate between the Trias and Lias, of which there was no representative in Europe.

Professor H. D. Rogers observed that this would indicate a more recent age for the bird-tracks of the Connecticut Sandstone.

Professor Agassiz remarked, in reference to the footmarks of the Potsdam Sandstone, which Professor Owen had described as those of turtles, but which he at the same time maintained were those of Crustaceans, have now been admitted by Owen himself to belong to the latter; so that there is no evidence that reptiles have been found below the coal.

Professor H. D. Rogers alluded to bones of reptiles having been found in Germany in strata equivalent to the carboniferous limestone, one degree older than the coal. Professor Agassiz doubts if these are reptilian bones.

Dr. Hayes connected the coal deposits of the two States by the additional fact, that the chemical constitution of the accompanying rocks, according to his own examination, is the same.

Professor Agassiz presented a list of fishes found in the Tennessee River, in all thirty-three species, and of several genera not found in Europe. He mentioned the fact, that many exclusively American species, found in the Southern States from Virginia downwards, are not found in the more Northern States; he indicated several localities of small extent, which have fishes exclusively their own, so that any former communication of rivers could not explain their limited geographical distribution. The genera are common over extended localities, but each region has its representative species.

Three hundred and ninety-first meeting.

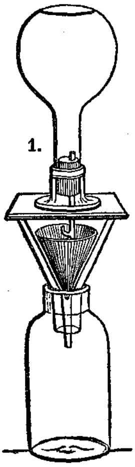
December 27, 1853. — SEMI-MONTHLY MEETING.

The Academy met at their Hall, the Corresponding Secretary, and afterwards the PRESIDENT, in the chair.

The Recording Secretary being absent, Mr. J. H. Abbot was appointed Recording Secretary *pro tem.*

Professor Cooke exhibited and described some apparatus contrived by him for excluding the action of atmospheric air during the process of filtration. By means of it, this process may be conducted either in a confined portion of air, *in vacuo*, or in any gas.

"It is frequently important in chemical analysis to conduct the process of filtration either *in vacuo* or in a neutral gas, and especially in an atmosphere free from carbonic acid. In order to overcome certain difficulties, I have been led to contrive an apparatus for this purpose, which I believe to be superior to all others now in use, both on account of its simplicity and its cheapness. The complete apparatus is represented in Fig. 1, and some of its parts enlarged appear in Fig. 2. It consists of a wide-mouthed glass bottle, into the neck of which is ground with emory a funnel (*a*, Fig. 2), having a short but large spout. This funnel is made sufficiently thick to resist the atmospheric pressure, and its rim is ground so that it may be closed air-tight by a glass plate, or by a brass plate, connecting with an air-pump. Within this outer funnel the common filtering-funnel is placed, resting loosely against its side so as to allow a free passage of air. In order to wash the precipitate, a glass plate having a hole an inch and a half in diameter drilled through its centre (*d*, Fig. 2) is substituted for the covering-plate. Through this passes the tube of the washing-bottle (*f*, Fig. 2). The washing-bottle is made in the ordinary way, except that it is fitted with a cork, which projects about an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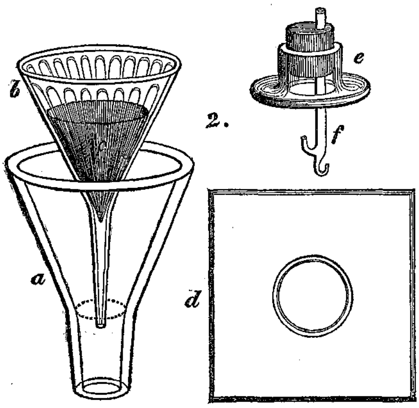
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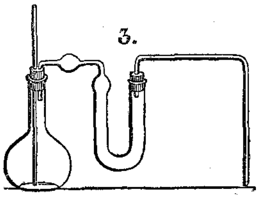
inch above the neck. The upper end of the cork fits the neck of a glass plate ground on the under side, made as is represented at *e*, Fig. 2. This plate is about three inches in diameter, and when resting upon the plate *d*, as is represented in Fig. 1, covers the hole completely, and permits sufficient lateral motion to bring the stream of water on different parts of the precipitate.

"Numerous processes in which this apparatus may be applied will suggest themselves to any chemist. I will only mention one in which I have found it very useful. In the ordinary process of separating alumina and sesquioxide of iron from the alkaline earths, the sesquibases are precipitated by caustic ammonia, which does not, as is well known, precipitate the alkaline earths when perfectly caustic. Since, however, the best liquid ammonia contains carbonic acid, and as, during the precipitation and subsequent filtration, carbonic acid is absorbed from the air, it invariably happens that small amounts of the alkaline earths are precipitated as carbonates. It becomes, therefore, necessary to redissolve the precipitate, and repeat the process in order to obtain a complete separation. This repetition, I think, may be avoided by using ammonia gas made caustic by lime, and conducting the filtration in the apparatus just described. The substitution of ammonia gas for liquid ammonia in this process has been made by many chemists. I use for precipitating with caustic ammonia gas the little apparatus represented in Fig. 3. Strong liquid ammonia is placed in the flask, where it is gently heated, and the resulting gas passed through a chloride of calcium tube into the solution. To the end of the bent tube I attach, by means of a caoutchouc connector, a short tube which dips into the fluid. This, when the precipitation is completed, can readily be disconnected, and any adhering precipitate easily removed. The fluid with the precipitate I now throw upon the filter arranged in the apparatus above described. As the process of filtering and the subsequent washing is conducted in a very confined space, which can easily be entirely deprived of carbonic acid, no precipitation of the alkaline earths is possible, so that they are completely separated from alumina and sesquioxide of iron at the first precipitation.



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"I use two sizes of the filtering apparatus, which differ from each other, however, only in the size of the bottle. In both, the diameter of the outer funnel is about five inches, but in one size the bottle has the capacity of a pint and in the other of a quart. I employ the larger size only when a prolonged washing of the precipitate is necessary. The cost of the apparatus complete is only two dollars, the price of an ordinary filtering-stand with iron rings."

Professor Gray presented a communication entitled, "Notices of New Species of Mosses from the Pacific Islands," by William S. Sullivant.

"The Mosses here noticed are a part of the collections made by the United States Exploring Expedition under the command of Captain Charles Wilkes; and are presented in this form for the purpose of securing to the Expedition the priority of their discovery. Similar notices of new Mosses and Hepaticæ from Tierra del Fuego and Oregon, belonging to the same collections, have already appeared in the second volume of Hooker's Journal of Botany (1850).

"1. HYPNUM APERTUM (n. sp.): monoicum; caule prostrato elongato arcte repente pinnatim ramoso; ramis dissitis inæqualibus complanatis; foliis laxissime bifariam imbricatis suboblique orbiculari-ovatis acuminulatis concaviusculis ecostatis firmiusculis subscariosis pellucidis estriatis integerrimis nitidis minute elliptico-areolatis; capsula suburceolata horizontali pendulave annulata; operculo hemisphærico-conico; pedicello flexuoso-erecto lævi. — Hab. On the ground, Tahiti, Society Islands.

"2. HYPNUM MOLLUSCOIDES (n. sp.): pusillum, dioicum; cæspite deplanato intricato mollissimo lutescente; caule fasciculatim diviso, divisionibus densissime plumæformi-pinnatis; foliis e basi lata lanceolato-attenuatis falcatis secundis vix serrulatis costellis binis brevissimis indistinctis minute lineari-areolatis cellulis basilaribus laxioribus majoribus; perichætialibus stricto-convolutaceis apice longe attenuatis patentibus; capsula minuta ovali-urceolata horizontali vel pendula; dent. peristomialibus lanceolato-subulatis dense trabeculatis, ciliis carinato-stereodontibus, ciliolis singulis binisve validis granulosis sæpe rimosis; annulo ægre solubili; operculo hemisphærico-conico recte rostellato; pedicello longiusculo gracillimo. — Hab. Tahiti, Society Islands.

"3. HYPNUM WILKESIANUM (n. sp.): dioicum, majusculum, sordide rufescens; cæspitibus extensis laxis; caulibus prostratis rigidiusculis

paucirameis vel dissite subpinnatis, ramulis longiusculis attenuatis teretibus vel subcompressis basi fructiferis; foliis ovato-lanceolatis concavis patenti-divergentibus incurviusculis ruguloso-striatis basi lata saccato-plicatis, margine toto ambitu serrulatis inferneque recurvis, costa valida ad apicem fere attingente, dense areolatis, cellulis minutissimis oblongis; perichætialibus exterioribus squarrulosis interioribus filiformi-elongatis erecto-flexuosis apice serratis; capsula cylindraceo-oblonga erecta subæquali annulata basi subattenuata; operculo longe erecto-aciculari-rostrato; pedicello flexuoso longissimo; peristomii dentibus lineari-attenuatis strictiusculis dense trabeculatis, ciliis e membrana eciliolata tenuibus carinatis; columella emergente; sporis majusculis; archegoniis 40 – 50; antheridiis 35 – 40; paraphysibus floris utriusque copiosissimis. — Hab. Hawaii, Sandwich Islands.

"4. Hypnum Pickeringii (n. sp.): monoicum, pusillum, plumulosum; cæspite compacto; caulibus inferne sordide rufescentibus superne aurescentibus nitidulis vage ramosis; ramis erectiusculis apice subuncinatis dense subcompresse foliosis; foliis oblongo-lanceolatis concavis filiformi-attenuatis basi patentibus dehinc erecto-incurvis apice subtubuloso serrulato patentiusculo interdum subsecundis ecostatis scariosis, cellulis densissimis valde elongatis transversim striato-granulosis plus minus minutissime papillulosis, alaribus utrinque binis ternisve subquadratis amplissimis vesiculæformibus hyalinis flavidulis; perichætialibus oblongo-convolutaceis subito serrato-acuminatis; pedicello longiusculo tenui debili superne tuberculoso-scaberrimo inferne lævi; capsula minuta ovali-urceolata subpendula; peristomii dentibus linea axili lata pellucida notatis dense articulatis intus valde prominenter lamellosis; ciliis e lata membrana carinatis foraminulosis capillari-attenuatis ciliolis singulis interpositis; operculo longissime aciculari-rostrato; calyptræ junioris cellulis spiraliter dispositis. — Hab. Mountains behind Honolulu, Oahu, Sandwich Islands.

"5. Hypnum arcuatum (n. sp.): monoicum, plumulosum, delicatulum; caule prostrato rectangulariter parce diviso, divisionibus breviusculis dense pinnatis, ramulis compressiusculis; foliis lanceolatis acuminatis serrulatis ecostatis patenti-divergentibus incurviusculis laxe positis distiche directis minute lineari-areolatis; capsulis inæquilateralibus annulatis e pedicelli longissimi arcu latissimo apiciali pendulis; operculo hemisphærico-conico; flore masculo gemmiformi cauligeno, antheridiis 8 – 10 paraphysatis. — Hab. East Maui, Sandwich Islands.

"6. HYPNUM MUNDULUM (n. sp.): monoicum, parvulum, delicatulum, pallide lutescenti-viride, laxe implexum; caule repente parce diviso pinnatim confertius ramuloso; foliis patentibus laxissime disticheque dispositis e basi constricta subauriculata lanceolatis longe acuminatis concaviusculis ecostatis, marginibus erectis superne lenissime serrulatis tenuissime lineari-areolatis, cellulis basilaribus amplissimis oblongis vesiculæformibus pellucidis; pedicellis aggregatis tenuibus longiusculis lævibus; capsula gibboso-brevi-oblonga; operculo conico acuminulato; perichætialibus oblongo-convolutaceis ex apice rotundata eroso-dentata subito in acumen longissimum filiforme flexuosum varie directum eductis; antheridiis 12–15, abunde paraphysatis; fol. perigon. filiformi-acuminatis. — Hab. District of Puna, Hawaii, Sandwich Islands.

"7. HYPNUM? SPECIOSISSIMUM (n. sp.): elatum, filicoideum, aurescente-spadiceum; caule (plantis masculis tantum visis) primario repente radiciformi robusto radiculis atropurpureis densissime vestito, stipites fuscos erectos firmos minute squamæformi-foliosos (veluti nudos) apice in frondem planam ovato-lanceolatam superne pinnatim inferne bipinnatim ramosam ramificatos emittente; ramis superioribus patentibus strictis hystricose-foliosis, inferioribus patentioribus rectangulariter ramulosis, ramulis breviusculis subgeniculato-flexis; foliis axis centralis majusculis dissitis strictis bifariis elongato-triangulari-lanceolatis longe acuminatis subplanis, rameis ramulinisque multo minoribus confertis erecto-patentibus e basi elongato-elliptica longissime lineari-eductis, omnibus superne argute serratis margine plus minus indistincte incrassato-limbatis costa dorso versus apicem dentata valida percurrente cuspidatis; areolatione densissima e cellulis minutis linearibus prosenchymaticis maxime pachydermibus composita; perigoniis numerosis valde conspicuis elongato-ellipsoideis acuminatis substipitatis axillaribus in ramorum axisque superiorum longitudine utrinque seriatim positis; foliis perigon. inferioribus minutis ovato-acutis, superioribus convoluto-lanceolatis filiformi-acuminatis usque ad apicem subdentatam costatis, interioribus late ellipticis convolutis breviter obtuse apiculatis mediotinus costatis; antheridiis 3–5 majusculis elongatis pedicellatis paraphysatis. — Hab. Feejee Islands.

"8. HYPNUM TUTUILUM (n. sp.): monoicum; caule prostrato extense arcteque repente bis terve diviso, divisionibus densissime pinnatis; foliis e basi constricta ovato-lanceolatis decurvo-falcatis subrugulosis lineari-areolatis basi brevissime bicostatis; capsula horizontali vel pendula suburceolata annulata, ore subobliquo; peristomii hypnoidei ciliolis cilia æquantibus ternatim interjectis; operculo hemisphærico-conico; pedicello lævi flexuoso-erecto; flore masculo gemmiformi cauligeno paraphysato. — Hab. Island of Tutuila, Samoan or Navigators' Group: also Feejee Islands.

"9. Hypnum Draytoni (n. sp.): dioicum, robustum, speciosum; cæspite laxo lato; caulibus prostratis elongatis flaccidis turgido-compressis parce divisis; foliis laxe imbricatis distiche-appressis oblongis ovato-oblongisve decurrentibus cochleariformi-concavis obtusis acumine brevi flexuoso terminatis lutescente-viridibus nitidulis pellucidis brevissime furcato-costatis, margine erecto integerrimo, cellulis elongatis angustissimis densis, infimis brevioribus amplioribus; capsula in pedicello lævi longiusculo rigido horizontali arcuato-oblonga annulata; operculo conico-acuto; peristomii dentibus lanceolato-subulatis dense trabeculatis, ciliis æquilongis carinatis imperforatis e membrana latissima, ciliolis brevioribus ternatim interjectis; antheridiis numerosissimis paraphysatis; perichætialibus ovatis seu ovato-lanceolatis, internis oblongo-lanceolatis basi vaginantibus margine superne subcrenato-undulatis. — Hab. Forest at the eastern base of Mauna Kea, Hawaii, Sandwich Islands.

"10. Hypnum aristatum (n. sp.): dioicum? robustum, rigidum, flavo-viride; caulibus 3–4-uncialibus erecto-flexuosis decurvis e massa radiciformi nigra sepulta assurgentibus parce ramosis, ramis elongatis abbreviatisve simplicibus raro subpinnatis hispidulose foliosis; foliis undique versis confertis erecto-patentibus strictis e basi subcordata oblongo-lanceolatis costa valida percursis longeque aristatis integerrimis margine inferne recurvis concavis subimplanis e cellulis subrotundis minutis densius conflatis; capsulis ovali-oblongis subæqualibus basi attenuatis; pedicellis breviusculis erecto-incurvis aggregatis prope apicem ramorum; peristom. dentibus lanceolatis subulatis dense articulatis, ciliis e membrana plicata lata carinatis lanceolatis attenuatis dorso hiantibus, ciliolis binis interpositis appendiculatis; perichætialibus parviusculis laxius imbricatis supra medium patentibus filiformi-eductis indistincte costatis; vaginula emergente oblonga; paraphysibus filiformibus 6–10 septatis; operculo et calyptra non visis. — Hab. Bay of Islands, New Zealand.

"11. HYPNUM OPÆODON (n. sp.): dioicum? aureo-flavidum, nitidum; caulibus prostratis irretitis latum densum cæspitem efficientibus breviusculis rectangulate divisis, divisionibus dense et eleganter pinnatis parum subbipinnatis; ramulis complanatis; foliis confertis ovato-lanceolatis acuminatis serrulatis subfalcatis secundis estriatis caviusculis ecostatis vel brevissime subbicostatis margine inferne reflexis, cellulis pallidis tenuissime linearibus, basi alisque 3 – 5 utrinque amplissimis vesiculæformibus flavidis hyalinis; perichætii longiusculi foliis exterioribus ovatis, interioribus oblongis striatis, omnibus vaginantibus longissime acuminatis acumine grosse dentato flexuoso; vaginula emergente copiose paraphysata; pedicello erecto-flexuoso sesquiunciali et ultra; capsula cylindraceo-oblonga erecta plagiostoma uno latere curvula in collum subglobosum abrupte desinente; operculo conico oblique rostrato; peristomii dentibus lineari-lanceolatis in axi plus minus fenestratis sinuato-articulatis veluti ad latera grosse irregulariter crenato-dentatis, ciliis e membrana plicata haud lata carinatis carina interrupte hiantibus, ciliolis subnullis; sporis majusculis. — Hab. Forest at the eastern base of Mauna Kea, Hawaii, Sandwich Islands.

"12. HYPNUM EUDORÆ (n. sp.): monoicum; caulibus prostratis elongatis complanatis paucirameis lutescentibus nitidis; foliis laxiuscule subbifariam imbricatis ovato-oblongis obtusis cymbiformi-concavis estriatis subito tenuiter inflexo-flexuoso-acuminatis integerrimis angustissime lineari-cellulatis marginibus erectis basi constrictis, costellis binis indistinctis vix ullis; perichætialibus longe cylindraceis apice attenuatis patentibus; capsula anguste oblonga erectiuscula subinæquali in pedicellum rubrum longiusculum clavellato-attenuata; peristomio euhypnoideo pallido, ciliolis binis longis; annulo duplici spectabili; operculo conico-brevi-rostrato; calyptra cuculliformi; vaginula conico-oblonga eparaphysata: gemma mascula cum paraphysibus. — Hab. Kaala Mountains, Oahu, Sandwich Islands.

"13. HYPNUM DECURRENS (n. sp.): dioicum? majusculum; cæspite aureo-nitente; caulibus prostratis elongatis subcomplanatis parce pinnatim ramosis, ramis distantibus inæqualibus subuncinatis; foliis laxiuscule imbricatis decurvo-subfalcatis e basi cordata auriculata decurrente lanceolatis tenuiter acuminatis concaviusculis substriato-implanis toto ambitu serrulatis margine erecto cellulis tenuissimis compactis, alaribus majoribus laxis pellucidis subquadratis, costis binis brevissimis subobsoletis; perichætialibus exterioribus oblongo-ovatis acuminatis, interioribus e basi oblonga in acumen longissimum ligulatum denticulatum flexuosum eductis ecostatis; archegoniis 35 – 40 abunde paraphysatis; pedicellis (in specimine unico fertili binis ex eodem perichætio) breviusculis erecto-flexuosis lævibus; capsula pachydermi horizontali gibboso-brevi-oblonga. — Hab. Kaala Mountains, Oahu, Sandwich Islands.

"14. HYPNUM TENUISETUM (n. sp.): monoicum; caule prostrato longissimo tenui flexili apice flagelliformi parce diviso, divisionibus dissite pinnatis ramulis brevibus; foliis patenti-divergentibus laxe sub-distichis e basi cordata lanceolatis concavis serratis indistincte brevissime bicostatis lineari-areolatis, cellulis marginalibus conspicuis; capsula minuta gibboso-oblonga pendula; peristomio (læso) hypnoideo; pedicellis numerosis gracilibus longis; perichætialibus filiformi-attenuatis flexuosis serratis dorso papillosis: flore masculo gemmiformi cauligeno paraphysato; operculo calyptraque deficientibus. — Hab. Island of Tutuila, Samoan or Navigators' Group.

"15. HYPNUM MOLLICULUM (n. sp.): monoicum, perpusillum, flaccidum, lutescente-viride, nitidulum; cæspite laxo; caule repente vage diviso, ramis adscendentibus compressiusculis laxe foliosis; foliis patentibus e basi lata subtruncata concava oblongo-lanceolatis tenuiter longe acuminatis apice cellula unica lineari terminatis brevissime obsolete bicostatis, areolatione laxiuscula e cellulis longissimis flexuosis basi multo brevioribus latioribus pellucidioribus composita; capsula subgibboso-oblonga; pedicello debili flexuoso lævi; peristomii dentibus late lanceolato-linearibus arcte articulatis, ciliis æquilongis carinatis e membrana lata ciliolis singulis interpositis; foliis perichætialibus laxe imbricantibus erectis, superioribus longissime acuminatis; vaginula emergente; antheridiis 4 – 5 haud paraphysatis. — Hab. Forest at the eastern base of Mauna Kea, Hawaii, Sandwich Islands.

"16. HYPNUM SODALE (n. sp.): dioicum? exiguum; cæspite laxo complanato sordide fulvo; caule decumbente semel diviso, divisionibus densissime pennæformi-pinnatis; foliis e basi lanceolata attenuatis falcato-secundis ecostatis lenissime serrulatis laxiuscule lineari-areolatis; perichætialibus laxis longe attenuatis flexuoso-erectis apice denticulatis; capsula ovato-urceolata exannulata horizontali pendulave; peristomii euhypnoidei ciliolis binis breviusculis; operculo hemisphærico recte breviter rostellato; pedicello tenuissimo longiusculo. — Hab. Eimeo, Society Islands.

"17. Hookeria Tahitensis (n. sp.): dioica? caule arcte repente radiculoso dense simpliciterque pinnato, ramulis brevibus obtusis basi fructiferis; foliis laxiuscule subbifariam positis, lateralibus patentissimis, ellipticis breviter acuminatis cymbiformi-concavis striatulis apice undulato-constrictis margine reflexis serratis breviter gemello-costatis tenuiter lineari-areolatis subpellucidis minute papillosis fulvo-viridibus nitentibus; perichætialibus erectis subconniventibus oblongo-lanceolatis plicatis ciliato-dentatis superne dorso ciliato-papillosis; capsula exannulata erectiuscula cylindraceo-oblonga subinæquali; pedicello breviusculo superne papilloso; peristom. dentibus lineari-lanceolatis dense trabeculatis, ciliis brevioribus carinatis e membrana modice exserta, ciliolis rudimentariis; operculo e basi conica longe subulato-rostrato; calyptra elongato-mitræformi pilis erectis simplicibus compositisve obsita basi pilis loriformibus denticulatis fimbriata. — Hab. Mountains of Tahiti, Society Islands.

"18. Mniadelphus Vitianus (n. sp.): dioicus; caule adscendente frondiformi simplicii vel raro 1–3 ramoso; foliis distiche imbricatis e basi oblonga orbiculari-spathulatis toto ambitu marginatis abrupte cuspidatis (cuspide torta) undulato-implanis glauco-viridibus mollibus pellucidis superne laxe rotundato- inferne laxissime oblongo- hexagono-areolatis mediotinus costatis; perichætialibus laxis ovali-ovatis concavis; capsula minuta ovali longicolla subæquali exannulata horizontali; dentibus peristomialibus dense articulatis linea lata pellucida notatis, pedicello valde tuberculato cygneo-flexuoso basi incrassato; operculo subulato-rostrato; calyptra mitræformi setoso-hirta basi cellulis longissimis simplicibus fimbriata: flore masculo gemmiformi stipitato axillari; antheridiis numerosis, paraphysibus subnullis. — Hab. On decayed wood, Feejee Islands.

"19. Hookeria debilis (n. sp.): caule prostrato irregulariter diviso arcte repente; foliis lanceolatis longe acuminatis ecostatis flaccidis dissitius positis varie directis flexuosis laxissime fusiformi-areolatis integerrimis; capsula clavato-cylindraceo elongata arcuata horizontali; operculo e basi ampla hemisphærica decurve longissime rostrato; peristomii dentibus linearibus acuminatis dense trabeculatis dorso rima lata hiantibus, ciliis carinatis e membrana basilari angustiore eciliolata; pedicello erecto longiusculo lævi; calyptra non visa. — Hab. Feejee Islands: also Samoan or Navigators' Group: growing on a Fern.

"20. HOOKERIA OBLONGIFOLIA (n. sp.): hermaphrodita; caule prostrato intricato-ramoso complanato; foliis oblongis laxius positis distiche imbricatis denticulatis dense minuteque rotundato-areolatis papillosis bicostatis costis validis fere ad apicem percurrentibus; pedicello longiusculo lævi erecto e caule primario; calyptra mitræformi leviter cristato-lineata basi in lacinias 10 – 12 canaliculatas fissa. — Hab. Samoan or Navigators' Islands; parasitic on Ferns.

"21. PILOTRICHUM SETIGERUM (n. sp.): dioicum? speciosum, molle, aureo-nitens; caule repente radiciformi nudo ramos subsimplices adscendentes elongato-subclavæformes bi-triunciales compressiusculos turgide foliosos apicem versus fructiferos emittente; foliis confertis erecto-patentibus ellipticis acuminatis longitudinaliter valde plicatis superne serrulatis ecostatis scariosis lineari-areolatis, cellulis exilissimis pachydermibus horizontaliter seriatis basi rufo-aurantiaceis; perichætiis exiguis; capsula (supramaturis et junioribus tantum visis) immersa ovato-cylindracea brevissime pedicellata pachydermi; perichætialibus inferioribus ovato-lanceolatis acuminatissimis, superioribus elongato-oblongis convolutaceis lævibus e basi fere ad apicem obtusum grosse dentatum ecostatis dehinc costa in setam longissimam rigidam dentatam excedente instructis; peristom. dentibus linearibus arcte articulatis transversim striatulis linea axili lata notatis; ciliis e membrana latissima plicata; operculo recto longe rostrato; calyptra mitræformi; archegoniis circa 24; paraphysibus dimidio brevioribus. — Hab. Feejee Islands.

"22. CRYPHÆA CUSPIDATA (n. sp.): monoica, parvula, sordide lutescens; caule primordiali prorepente defoliato; ramis uncialibus et ultra adscendentibus arcuato-reclinatis pinnatim et fasciculatim breviramulosis; foliis madefactis erectis, siccis arcte adpressis ruguloso-striatis late ovatis acuminatis ovato-lanceolatisve cymbiformi-concavis integerrimis carinato-costatis, costa valida cum apice evanescente, margine inferne recurvo, cellulis minutis subpunctiformibus; perichætiis in ramulis brevissimis terminalibus numerosis seriatis secundis; foliis perichætialibus interioribus oblongis costa rigida longe excurrente cuspidatis; capsula immersa oblongo-ovata breviter pedicellata speciose annulata; operculo e basi conica oblique rostrato; peristom. dentibus lineari-lanceolatis linea mediali notatis trabeculatis apice granulosis, ciliis angustioribus æquilongis subappendiculatis; calyptra mitræformi-dimidiata apice papillulosa: gemmis. masc. axillaribus subpedicellatis;

antheridiis 5 – 7 longe pedicellatis; paraphysibus paucis curtis; foliis perigon. late ovatis recurvo-apiculatis ecostatis sublimbatis. — Hab. Vicinity of Valparaiso, Chili.

"23. Neckera tricostata (n. sp.): dioica? majuscula, fusco-lutescens; caule primario repente radiciformi subterraneo ramos erectos inferne atratos defoliatos superne speciose dendroideo-ramulosos emittente, ramulis elongatis flexuosis simplicibus compositisve dense foliosis fructiferis; foliis erecto-patentibus incurviusculis e basi lata subtruncata ovato-oblongis acuminatis concavis carinato-costatis, costa valida cum apice desinente, toto ambitu incrassate limbatis veluti tricostatis superne grosse serratis, cellulis compactis minutis subpunctiformibus; perichætii oblongi foliis arcte imbricatis, inferioribus subsquamæformi-orbiculatis, superioribus ad medium erectis oblongo-convolutaceis dehinc subito horizontaliter reflexis tenui-acuminatis, omnibus ecostatis interrupte pellucide sublimbatis; archegoniis 45 – 50 paraphysibus numerosis fere duplo longioribus 30 – septatis basi interdum composite cellulatis; cætera desunt. — Hab. Forest at the eastern base of Mauna Kea, Hawaii, Sandwich Islands.

"24. Rhizogonium pungens (n. sp.): dioicum; cæspite denso hispido e viridi spadiceo; caulibus bi-triuncialibus basi fructiferis erectiusculis simplicibus inferne tomento atropurpureo dense vestitis; foliis laxiuscule dispositis patenti-divergentibus carinato-concavis semiuncialibus (arista inclusa) strictiusculis rigidis pungentibus elliptico-lanceolatis costa valida subtereti in aristam dorso et lateribus grosse dentatam lamina quintuplo longiorem excurrente instructis basi valde incrassatis e cellulis minutis densis subquadratis compositis, margine duplicato-dentato vel potius bilamelloso, lamellis dentatis; perichætiis radicalibus brevissime stipitatis; foliis perichætialibus exterioribus lanceolatis dentatis, interioribus oblongis integerrimis, omnibus laxius reticulatis basi vaginantibus costa excurrente valida dentata longissime aristatis; archegoniis longiusculis numerosis (40 – 50) copiose paraphysatis, paraphysibus 7 – 10-septatis archegonia paululum superantibus. — Hab. District of Puna, southwest coast of Hawaii, Sandwich Islands."

Professor William B. Rogers called the attention of the meeting to the different explanations which have been given of the two vertical beams of light which are seen stretching, the one upwards and the other downwards, from a luminous

point, as the flame of a candle, when we view it with the eyelids nearly closed. He said that until lately he had been accustomed to refer this phenomenon to *reflection* from the surfaces of the two eyelids, the lower surface reflecting the incident rays upwards through the eye, the upper surface in the opposite direction. From the oblique incidence of the light in each case, the minute irregularities of the surface might be supposed to have the effect, by a linear conjunction of images, of prolonging the picture on the retina, just as the ripples on a lake elongate the image of the moon, or of a burning torch when in a suitable position, so as to form a luminous band stretching over the water from beneath the object nearly to the spectator. A similar explanation has recently been suggested by M. Trouessart in the *Comptes Rendus*.

The seventh number of Poggendorf's *Annalen* for the present year contains a paper on this subject by H. Meyer of Leipsic, in which he refers these vertical beams to *refraction*. As the eyelids are moved over the eyeball, they gather before them the moisture which continually lubricates the surface of the eye. Owing to the oily secretion of the lids, this moisture, instead of spreading on their surface so as to form a concavity outwards, is by the opposite capillarity moulded into a converse form, which may be approximately regarded as a quarter-cylinder lying in the angle of junction of each eyelid with the cornea. The light striking the upper of these convexities will by refraction be bent upwards through the eye, and that incident on the lower will be bent downwards. In this view, therefore, the upper eyelid is the one concerned in producing the beam which appears vertically under the object, and the lower eyelid in producing that which appears vertically over it. But by the hypothesis of reflection the reverse of this must be the case, the beam above the object being due to the action of the upper eyelid, and the opposite beam to the lower eyelid.

Professor Rogers mentioned a simple experiment, which proves that the latter cannot be the true explanation, and which makes it extremely probable that M. Meyer has hit upon the correct one. If, when the eyelids are adjusted so as to develop the two vertical beams in great length and brightness, we cautiously lift away the *lower* eyelid from the cornea without changing the distance between the two eyelids, we observe that the *upper* beam instantly disappears; and so, on lifting the upper eyelid, the lower beam vanishes. This is just what ought to happen according to Meyer's view of the origin of the beams. The lifting of the eyelid, by breaking up the convexity of liquid, must of course put a stop to the fan-shaped refraction, and therefore extinguish the vertical beam corresponding to it above or below the luminous object. As the reflection from the surface of the eyelid would be but little altered by the slight removal from the cornea, we ought on the hypothesis of reflection either to find the two vertical beams unaltered, or that beam which is on the same side as the eyelid merely a little feebler and shorter. If, again, we revolve one of the eyelids entirely out of the range of action, while the other is retained in its place, the beam which disappears is found to be for the lower lid the upper beam, and for the upper lid the lower beam, as ought to be the case according to Meyer's explanation.

Professor Peirce made a communication on the relations of curves of which the equations are $\left\{\begin{matrix} P=0 \\ Q=0 \end{matrix}\right\}$, in which the functions are derived from the equations $f(x+y\,.\,\sqrt{-1}) = P + Q\sqrt{-1}$.

Professor Agassiz added some remarks, in which he pointed out some interesting analogies, suggested by Professor Peirce's communication, in certain organic forms in the vegetable and animal kingdoms.

Professor Cooke called the attention of the Academy to some remarkable relations he had discovered between the atomic weights of the elements; and to some new facts which a knowledge of those relations had led him to observe. He considered the common classification of the elements as not founded on correct principles. Disregarding the distinction of metals and metalloids, and guided chiefly, though not exclusively, by the mode of combination and crystalline form, and bringing together those elements which bear the closest relations to each other, he had arranged the elements in six groups, the properties of each of which are closely related to each other, while they differ widely from those of any other group. The elements of any one group are, for the most part, isomorphous, and from similar compounds. Arranging the elements of any one group according to their relative affinities, and commencing with the strongest, he had found that the physical properties follow the same progression. As in organic chemistry differences of properties correspond to fixed differences of composition, he had noticed that, in like manner, in these series of inorganic chemistry, similar differences manifest themselves in differences of atomic weights. In the series in which he had classified the elements, the differences between the atomic weights of the consecutive members of any one series is always a multiple of some whole number. In one case it is 9, in another 8, in another 6, in another 5, in another 4, and in another 3. He stated that there are some discrepances between the atomic weights, as at present determined, and those required by his theory; and that, though in most cases they are within the limits of actual error, in others there is a residual. These remarks Professor Cooke illustrated very fully by referring to the group consisting of oxygen, nitrogen, phosphorus, arsenic, antimony, and bismuth. He showed that these elements have the same mode of combination; that they not only unite with the same number of atoms, but that the resulting compounds have similar properties, and form parallel series with the elements. He stated reasons for believing that phosphorus, antimony, and arsenic exist in two allotropic states. He had succeeded in crystallizing arsenic in regular octahedrons which belong to a new allotropic state of arsenic; which in this state differs in color, weight, and chemical properties from common arsenic.

He thought there could be little doubt that the members of the nitrogen series are isodimorphs, forming two isomorphous series, one rhombic and the other monometric; and that it was highly probable that the residuals he had noticed in some of the elements might be owing to a difference in the atomic weights of those elements in their two allotropic states.

An interesting discussion followed Professor Cooke's communication, in which Professor W. B. Rogers, Professor H. D. Rogers, and Professor Peirce took part. It was stated by Professor Peirce that the number *seven*, omitted in the common differences between the atomic weights of the elements, was also omitted in the series of fractions representing the relative distances of the planets from the sun, and the distribution of leaves around the stem of a plant.

Professor Agassiz made a communication on the fundamental law of distribution of organic forms. Further remarks on the same subject were made by Professor H. D. Rogers, in respect to its geological relations; by Dr. Pickering, who described the method he had followed in his researches respecting the distribution of animals; and by Professor Peirce.

Three hundred and ninety-second meeting.

January 10, 1854. — SEMI-MONTHLY MEETING.

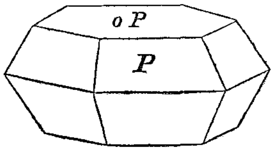
The PRESIDENT in the chair.

The Corresponding Secretary, by appointment, acted as Recording Secretary, after the reading of the proceedings of the last meeting by J. Hale Abbott, the Secretary *pro tem.* of that meeting.

Dr. Hayes made a verbal communication on the disappearance of marsh-gas (light carburetted hydrogen) in nature, — occurring, as he had ascertained, by its spontaneous combustion, converting it into carbonic acid and water at ordinary temperatures, even at 32° Fahr. He had ascertained the same fact in respect to carbonic oxide also.

Remarks on this communication were made by Professor Cooke and Professor Horsford.

Professor Cooke made the following communication: —



P on $o\,P$ = 122° 15′
P on P = 129 56
R on R = 85 47
a = 1.374

"The above drawing is an accurate representation of a crystal of rhombic arsenic which was picked out from a quantity of sublimed arsenic. The length of the lateral axes is about one third of an inch, and the crystal almost perfect. The angle of P on $o\,P$ was measured by a reflective goniometer, which reads to minutes. The faces were very perfect, but somewhat dull, owing to a slight tarnish. This made it difficult to measure with the usual signals, but the difficulty was easily overcome by making the measurements in a darkened room, and using for the upper signal a horizontal slit cut in a piece of turned iron about four inches in length and one fourth of an inch in diameter, which was fastened to the upper part of a window-sash, and the rest of the window covered with black cloth. The lower signal was a black line drawn on a white card. In this way very perfect and sufficiently bright images of reflection were obtained, as will appear from the fact that the greatest difference between twelve measurements did not exceed two minutes. The angle given (P on $o\,P$) is the mean of the twelve. The other angles were obtained by calculation.

"The angle R on R, as given by G. Rose, is 85° 4′, by Breithaupt 85° 26′, by Miller 85° 41′. My own measurements gave 85° 47′. This difference, too great to be referred to any errors of observation, is probably occasioned by apparent variations in the angle produced by striæ. Of ten or twelve crystals which I have examined, the one described above was the only one which had perfect planes. On some larger crystals, having the same form as the one described, the angle R on R measured approximately 85° 20′ and 80° 31′. The variation from the normal angle was evidently caused by striæ, which spread out the image of the signal into a broad band formed apparently by several images overlapping each other. (In measuring, the brightest portion of this band was selected as the starting-point.)

These striæ were most developed on the face P, and corresponded to the edges of planes of cleavage, which, as is well known, is eminent parallel to $o\,P$. One of these angles is almost identical with that given by Breithaupt. I place, however, no confidence on the accuracy of the measurement, on account of the imperfection referred to. It is, however, worthy of remark, that the angles of Rose, Breithaupt, and my own, give semiaxes divisible by fourteen, or so slightly differing from a multiple of fourteen, that the difference is fully covered by the possible errors of observation. We might conclude from this that the three observers had measured angles between different planes of the same series, were it not that the ratios between the parameters are so improbable as will appear from the following table: —

R on $R = 85^\circ\ 4'$	$a = 1.402$	nearly 14×100	Rose.
R on $R = 85\ 26$	$m\,a = 1.388$	" $14 \times 99\ m = \frac{99}{100}$	Breithaupt.
R on $R = 85\ 41$	$m\,a = 1.378$		Miller.
R on $R = 85\ 47$	$m\,a = 1.374$	" $14 \times 98\ m = \frac{98}{100}$	Cooke.

Dr. Charles Pickering, at the request of Professor Agassiz, exhibited a map illustrating the distribution of quadrupeds over the earth; and Professor Agassiz exhibited, and compared with this, a map which he had just prepared, illustrating the distribution of animals generally.

On motion of Mr. Treadwell, it was

"*Voted*, That the second monthly meeting of the present month be passed over, on account of the occurrence of the quarterly meeting in this month.

Three hundred and ninety-third meeting.

January 25, 1854. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from the Academy of Natural Sciences, Philadelphia, acknowledging the reception of Vol. V. Part I. of the Memoirs of the Academy.

Messrs. Treadwell, Emerson, and Eliot were appointed a committee to arrange for a course of lectures before the Lowell Institute the next season. The course for 1853-4 was given as follows, beginning on Tuesday evening, October 25th, at half past seven o'clock: —

By Professor Joseph Lovering, What is Matter?

By Professor Joseph Lovering, What are Bodies?

By Charles Jackson, Jr., Esq., History of the Useful Arts.

By Professor H. L. Eustis, The Britannia Bridge.

By Professor J. P. Cooke, Light.

By Professor A. Guyot, Psychological and Physical Characters of the Nations of Europe, compared with those of the American People.

By Professor A. Guyot, The same subject continued.

By Professor Asa Gray, The Relation of Plants to the Sun.

By Professor Asa Gray, The same subject continued.

By Dr. A. A. Gould, Aquatic Life.

By Professor Joel Parker, The Science of the Law.

By Professor H. D. Rogers, The Arctic Regions.

Mr. Folsom proposed a plan for printing the additions to the library, as they accrue, with a small form of type and a hand-press, and pointed out its advantages; the subject was referred to a committee, consisting of the Librarian, Mr. Folsom, and Dr. Gray.

Professor Horsford made a communication upon a mode of rendering gutta percha elastic by the action of sulphur and oxide of lead, so as to render it useful as a substitute for india-rubber for car springs and other purposes where elasticity is required, — an important desideratum, on account of the increased price of india-rubber. He had succeeded in his endeavor, but the substance was not equal in value to vulcanized india-rubber. Specimens of gutta percha thus prepared, with various degrees of elasticity, were exhibited.

Three hundred and ninety-fourth meeting.

February 14, 1854. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

The Academy met at the house of Professor Treadwell, in Cambridge.

The Corresponding Secretary acted as Secretary, and read the record of the proceedings of the last meeting.

Dr. J. Wyman exhibited to the Academy a dissection of the brain, nerves, and electric organs of the *Torpedo occidentalis*, Storer, which is occasionally captured at Provincetown, Cape Cod, and adjoining localities, during the month of November. As regards its anatomical structure, it does not differ materially from the European species. Dr. Wyman estimated the number of plates or laminæ composing the two batteries at between 250,000 and 300,000; the number of prisms was about thirty-six to the square inch. He was able to trace the minute structure of the laminæ with the microscope, and found the ultimate distribution of the nerves to be the same as described by Wagner. Each ultimate nerve-fibre on reaching the lamina divides into a series of branches, which unite and form a complete capillary network over the surface of the plate; but from these branches others are given off, into which the "white substance" of Schwann does not enter. These last branches also divide; but at the point of division a large nucleated cell is generally found; and the fibres proceeding from this terminate in exceedingly slender, minute points, which seem to be lost on the general surface of the plate.

Professor Horsford read a paper by his pupil, Mr. Dean, embodying the results of a series of experiments on the nutritive value of various amylaceous articles of food, estimated from the percentage of nitrogen they respectively contain. Some remarks were made upon this by the President and Dr. Gray.

Professor Horsford also exhibited specimens of the ferruginous incrustation of the Cochituate water-pipes, which in some places had occurred to such extent as to diminish their calibre by one sixth, and the flow of water as much as twenty per cent. He thought the incrustation did not proceed now at so large a rate as at first. The President, Mr. Treadwell, and Mr. Charles Jackson, Jr. made various inquiries; but the reason why some pipes were more acted upon than others was not elicited.

Dr. Gray exhibited specimens of a *Spongilla* taken from the Cochituate water-pipes, in which, at some places, especially where there is no rapid flow, this production is said to form with great rapidity.

Three hundred and ninety-fifth meeting.

February 28, 1854. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary acted as Recording Secretary, and read the record of the proceedings of the preceding meeting.

Professor Cooke submitted a memoir upon a subject which he had brought before the Academy at a former meeting, viz. "The Numerical Relation between the Atomic Weights, with some Thoughts on the Classification of the Chemical Elements." This was illustrated by a new classification of the elements in natural groups.

Dr. W. F. Channing stated that he had recently assisted in measuring the electricity evolved by two large magneto-electric machines constructed in Providence. These consisted essentially of armatures with inducing coils revolving before magnets. The amount of electricity evolved by the smaller machine was equal in quantity and intensity to that from a series of fifteen Grove's cups in full action. The amount of electricity evolved from the larger machine was equal to that from one hundred and forty-four Grove's cups, arranged two abreast in a series of seventy-two. The interesting fact here is, that galvanic electricity may be obtained from the magneto-electric machine for practical purposes, in greater quantity and at less cost than from the galvanic battery.

Professor Cooke communicated the fact, that an alloy of zinc, with a small quantity of antimony, after having been acted upon by dilute sulphuric acid, and then washed free from acid and left in water, continued to evolve pure hydrogen for the space of two months, at the ordinary temperature of the air; in considerable quantities, at the temperature of 60° or 70° Fahr.; and in lesser quantity, but without interruption, at 32°. Professor Cooke conjectured that this was owing to the zinc being thrown from the passive to an active state by the action of the acid and of the antimony; but Dr. W. F. Channing attributed it to the galvanic action developed by the acid, in partly detaching the crystals or particles of the antimony from the zinc, so as to form galvanic circuits.

Three hundred and ninety-sixth meeting.

March 14, 1854. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

The Academy met at the house of George B. Emerson, Esq.

The Corresponding Secretary laid before the Academy a letter from Professor Peters, of Königsberg, acknowledging his election as Foreign Honorary Member of the Academy; a letter from the Museum of Practical Geology, London, acknowledging the reception of the New Series of the Academy's Memoirs to Vol. V. Part I., and Vols. I. and II. of the Proceedings; letters from the Royal Institution, the British Museum, the Linnæan Society, the Society of Antiquaries, and Chevalier Bunsen, acknowledging the reception of Vol. V. Part. I. of the Academy's Memoirs, and pp. 233 to 359 of Vol. II. of the Proceedings; and a letter from the Academy of Natural Sciences, Philadelphia, acknowledging the reception of Vol. V. Part I. of the Academy's Memoirs.

Professor Treadwell made a communication "On the Measure of Force." In the Newtonian theory, the measure of force is the mass multiplied by the velocity, or as the momentum; according to the theory of Leibnitz and his followers, it is the mass multiplied by the square of the velocity. The philosophers who have maintained the first theory are chiefly English; those who favor the latter theory are chiefly Continental. The object of the communication was to render intelligible, by a simple illustration, the truth of the second theory.

Dr. A. A. Hayes exhibited and described a modification of the Photometer invented by Ritchie, by which the illuminating power of two flames can be directly compared.

He alluded to the different methods by which the attainment of an accurate measurement had been sought for, by intercepting light and comparing shadows, and pointed out the objections to them; concluding by expressing his opinion that Bunsen's mode, in its adaptation by Mr. King, with the improvements of Mr. Lewis Thompson, gives the nearest approximation to correctness which has been attained.

The instrument exhibited, in the arrangement of the two mirrors and admission of light from the two flames, was essentially Ritchie's. But the modification which renders it a more accurate indicator, and more generally useful, consists in reversing the position of the mirror-plates, and removing the oiled paper, so that the two beams of reflected light are projected downward in a small darkened chamber upon a printed page. Two rectangles of light, side by side, are thus made to illuminate a page, the printed lines on which pass across the chamber and have the same words occurring within the lighted space from each flame. The page is viewed through a partly opened leaf in front, and being at a convenient distance from the eye, a slight inequality in the light on either side is readily seen.

In making the experimental comparisons, the centre of one mirror in the instrument was placed at one hundred and twenty inches from a gas flame by moving the light pedestal supporting it, and on which it slides. A spermaceti candle burning

128 grains per hour, contained in a spring stand, was placed in line on an adjusting support. Motion of either the instrument or candle allowed the line of direction to be found and maintained constant during the experiment. The candle was allowed to burn until the projecting wick dropped its light ash away from the candle, when its burning was constant.

Dr. Hayes alluded to the fact, that the color afforded by the two beams of light was different; and this was apparent on the page, that from the gas light being nearly white, while a brown tint was given to the page by the flame of the candle. He stated that, as the light of flames is due to the ignition of solid matter, the illuminating power of any combustible cannot be inferred from its chemical composition, and although, as a general rule, those gases or vapors which deposit solid, finely divided matter by heat are found to be the best for illumination, yet the introduction of finely divided solid matter into flames composed of hydrogen or atmospheric air will produce luminous effects with the same variations in color.

In observing the page, as illuminated by the two rectangles of light, the eye soon accustoms itself to judging of the sharpness of the outline of the letters, irrespective of the color of the paper, and by retiring backward slightly, the vanishing of the letters on either side is distinctly marked, and the candle can be adjusted to produce equality. The distance of the gas light from the centre of one mirror being constant, the ratio of the light is learned by dividing the square of the gas distance by the square of the candle distance.

The illuminating power of the gas burned in this city had been the subject of his experiments, from which he obtained the result, that (for the last nine months) the light from one burner is equal to that of about twenty candles. The best solid material for illumination is the sperm candle; the illuminating powers of wax and sperm candles are as twelve to sixteen.

Professor Gray read the following communication on the age of a large California Coniferous tree.

“The age attained by the largest known trees is a matter of considerable interest; but it is seldom that an opportunity occurs of testing it by an actual counting of the annual layers of the trunk. This is said to have been done in the case of the gigantic tree recently felled near the head of the Stanislaus River, on the Sierra Nevada, California, a section of the trunk of which, at twenty-five feet from the ground and hollowed out to a shell, is now on exhibition at Philadelphia. The trunk of this tree ‘was sound from the sap-wood to the centre’; and its annual layers are very distinct to the naked eye in pieces of the wood in my possession. The size of this tree is such as to give it a presumptive claim to rank among the oldest of the present inhabitants of the earth; its length being 322 feet; the diameter of the trunk, at 5 feet from the ground, 29 feet 2 inches,
at 18 “ “ 14 “ 6 “
at 200 “ “ 5 “ 5 “
including the bark. These measurements are copied from Mr. Lobb's account of the tree, published in England, except the height (by Lobb said to be about three hundred feet), which I have given on the authority of the proprietor of the section now at Philadelphia. This section was taken at the height of twenty-five feet from the ground, and, according to the measurement of my friend, Thomas P. James, Esq. of Philadelphia, it is about twelve feet and a half in diameter, including the bark. Mr. James, at my request, has taken careful measurements of the wood itself, excluding the bark. The three diameters taken by him respectively measure 9 feet 6 inches, 10 feet 4 inches, and 10 feet 10½ inches: the average diameter of the trunk at the height of twenty-five feet from the ground is a little over 10 feet 3 inches. From the statements which have appeared, it would seem as if the layers had actually been counted, and ascertained to be 3,000 in number. This surely ought to have been done; but an examination of the statements does not prove that it was. Mr. Lobb's statement, as definite and reliable as any, is, that ‘the trunk of the tree in question was perfectly solid, from the sap-wood to the centre; and, *judging* from the number of concentric rings, its age has been *estimated* at 3,000 years.’

“The number of layers, therefore, has only been *estimated;* and we are not in possession of the exact data on which the estimate was founded. The data wanting are the average thickness of the layers towards the centre, giving the rate of the tree's growth as a young and middle-aged tree, when it must undoubtedly, like other trees, have increased more rapidly than in later years.

"Dr. Lindley, I find, (in the Gardener's Chronicle,) has accredited the estimate which assigns to this tree an age of above 3,000 years; stating that 'it may very well be true, if it does not grow above two inches in diameter in twenty years, which I believe to be the fact.' That rate would indeed give 3,500 layers at the height of five feet from the ground, where it is 29 feet 2 inches in diameter. But this measurement appears to include the bark, — to allow for which Dr. Lindley would perhaps give up the odd 500 years. There is a further consideration. At twenty-five feet from the ground the diameter of the wood is nearly 10 feet 4 inches. Here the rate of two inches in diameter in twenty years would give the trunk an age of only 1,230 years, so that, on these data, the tree in its youth would have been 1,770 years in adding twenty feet to its stature! Evidently the base of the trunk is enlarged somewhat in the manner of Taxodium and other allied trees, when old.

"The section of the trunk at Philadelphia has been hollowed out, by fire and other means, to a shell of 3 or 4½ inches in thickness. Of this I have, through the kindness of the proprietor and of Mr. James, a piece of the wood, including nearly three inches of this section. What is now wanted, and what unfortunately I do not possess, is a foot or two of the wood from the central parts of the tree, — a desideratum which may doubtless be supplied hereafter. The data at hand, however, will suffice for determining an age which the tree cannot exceed, unless it be supposed to have grown more slowly during the earlier nine tenths of its existence than during its later years, — which is directly contrary to the ascertained fact in respect to trees in general. Now the piece of wood in my hands exhibits an average of 48 layers in an inch. The semidiameter of the trunk at the place where it was taken is 5 feet 2 inches. If the tree increased in diameter at the same rate throughout, there would have been 2,976 annual layers; which, allowing 24 years for the tree to have attained the height of 25 feet, would give it an age of 3,000 years from the seed. This corresponds so closely with Dr. Lindley's estimate, that we may suppose him to have employed equivalent data in a similar manner. How great a deduction must we make from this estimate, in consideration of the greater thickness of the layers as a younger tree? The only direct data I possess bearing on this point are derived from a piece of a transverse section, 3½ inches deep, of a 'rail' which the exhibitor says was taken from the trunk at the height of 275 feet from the ground. As its layers, on a breadth of nearly seven eighths of an inch, show only a slight perceptible curvature, it must have come from a part of the trunk still of several feet in dimeter. On this section the exterior inch, nearly all alburnum, contains 90 layers; the next, 60; the next, 45; the remaining half-inch, 16, making 32 to the inch. That the exterior layers should be thinner at this height than those near the base of the tree, is just what would be expected. If we apply this ratio of decrease of the number of layers to the inch as we proceed inwards, to the section at twenty-five feet from the ground, we should, at four inches within that part of the circumference which I have examined, have only 17 layers to the inch, which, taken as the average thickness, would make the tree only 1034 + 24 = 1058 years old. But it is not probable that the thickness of the layers increases so rapidly. The data we possess on other trees go to show that a tree, after it is 400 or 500 years old, increases in diameter at a pretty uniform rate for each twenty additional years, on the whole, although the difference in the thickness of any two or more contiguous layers, or of the same layer in different parts of the circumference, is often very great. Still, when we consider how very much thicker are the annual layers of a vigorous young than of an old one, perhaps we should not be warranted in assuming more than the average of 17 layers to the inch for the whole section.

"Some useful data may be obtained from a tree more nearly related than any other to the two California ones, though of a different genus, namely, the so-called Cypress of our Southern States (*Taxodium distichum*). I possess three sections of different trees of Taxodium, reaching from the centre to the circumference. One of these, on an average radius of 27 inches, exhibits 670 layers; a second, on a radius of 30 inches, has 525; a third, on a radius of 22 inches, has 534 layers. The average is 576 layers to a semidiameter of 26 inches, or about 22 layers to an inch. Half of this growth (13 inches radius) was attained at the close of the first century; while the exterior layers of the oldest specimens were only the fiftieth or sixtieth of an inch in thickness. We have reason to believe, therefore, that the *Wellingtonia* (as it is called) of California is at least as rapid in its growth as the Taxodium. We may safely infer, I think, in the absence of other data, that when the tree in question had attained the size of 26 inches in semidiameter, it was only 576 years old. If thereafter we suppose it to have increased at the intermediate rate of 35 layers per inch for the next 26 inches, and at the actual rate of the last century (as ascertained by inspection), namely, at 48 layers per inch, for the remaining 10 inches, we should assign to it the age of 2,066 years as its highest probable age. I think it more likely to be shown, when the wanting data are supplied, that the tree does not antedate the Christian era. There are said to be eighty or ninety such trees, of from ten to twenty feet in diameter, growing within the circuit of a mile from the one felled. When the next of these venerable trees is wantonly destroyed, it is to be hoped that its layers will be accurately counted on the whole section, and the thickness of each century's growth carefully measured on the radius.

"The tree in question is a near relative of the *Redwood* of California, namely, the *Taxodium sempervirens* of Don, of late very properly distinguished as a separate genus under the unmeaning and not euphonious name of *Sequoia*, — a tree now growing in England, and sparingly also in our own vicinity, where it is barely hardy. My friend, Dr. Torrey, has for nearly a year possessed specimens of foliage of this tree, which he took to be a new species of Sequoia. The fruit and branches of the juniper-like foliage (probably only one form of a dimorphous foliage, which is common in *Cupressineæ*) having been received in England from Mr. Lobb by Dr. Lindley and Sir William Hooker, they have recognized in this tree the type of a new genus distinct from Sequoia, to which the former has given the name of *Wellingtonia*. The wood is, I believe, much the same as that of the Redwood, which tree also attains a gigantic size. The principal characters yet ascertained are that the cones of Wellingtonia are oblong, and have a thick woody axis. Additional materials are needed to confirm the genus, if such it be."

Mr. Paine made the following communication on the approaching eclipse of the sun: —

"On the afternoon of Friday, the 26th of May next, there will be an eclipse of the sun visible and generally large throughout the United States, and actually annular in part of the Territories of Washington and Minnesota, of Vancouver's Island, of Canada West, and of the States of Michigan, New York, Vermont, New Hampshire, Maine, and Massachusetts.

"A central, or very nearly central, solar eclipse, at any place, is indeed of rare occurrence. At the city of Paris only one takes place in the 133 years between 1767 and 1900, and although in Boston we have been more favored than Paris, the phenomenon in the century and a quarter between 1775 and 1901, and perhaps many more years, occurs here but four times; namely, in the annular obscurations of April 2, 1791; May 26, 1854; and September 28, 1875; and in that which was total, on June 16, 1806. The eclipse of February 12, 1831, was also annular at Nantucket and at Chatham, Cape Cod, but not elsewhere in New England.

"From computations, the results of which are more particularly given below, it appears that the path of the central eclipse of the 26th of May first enters upon the earth in the North Pacific Ocean near the Caroline Islands, in Lat. of about 6½° North, Long. 197° West; thence taking a northeasterly direction, it touches our continent near Cape Flattery in Washington Territory; it thence passes over Vancouver's Island, British Oregon, Minnesota, Isle Royale, Lake Superior, Canada West, New York, Vermont, New Hampshire, and Maine, to the Atlantic, where it leaves the earth in Lat. of about 36°, Long. 52°, having in $3^{h.}\ 41^{m.}\ 21^{s.}$, the time of its continuance thereon, run over 145½ degrees of longitude and 56 of latitude.

"It, moreover, appears that the duration of the ring, where central, in Washington Territory, is four and a half minutes, (which is nearly its longest duration at any place,) and in New York and New England somewhat less than four, although the ring is about ten seconds broader, and the distance between the lines of the northern and southern limits of the annular phase about thirty miles greater in the northeastern than in the northwestern part of the United States.

"In the Northeastern States, these limits will be well represented by lines drawn on a map, one from the southwestern part of the island of Montreal, over the southern part of the towns of Gardiner and St. George in Maine, to the ocean, and another from Ameliasburg in Canada West, over Ellisburg and Saratoga Springs in New York, Bennington, Vt., Leyden, Sterling, Dedham, Marshfield, and Orleans, in Massachusetts. These lines will be nearly parallel, and distant about 145 English miles, and will include between them the northeastern part of New York, nearly the whole of Vermont, all but the northern part of New Hampshire, the southwestern part of Maine, and, in Massachusetts, the northeastern part of the counties of Franklin, Worcester, Norfolk, Plymouth, and Barnstable, nearly the whole of Middlesex, and the whole of Suffolk and Essex. A third line, drawn nearly equidistant between the two others, from the southern part of Isle Royale in Lake Superior to Ogdensburg, N. Y., thence over Middlebury, Vt., Hanover, Sanbornton, Gilmanton, and Rochester, N. H., to the ocean at Cape Neddock in York, Maine, will represent the path of the *central* eclipse; as a fourth, from Gibraltar Point, near Toronto, C. W.; over Delhi and Kingston, N. Y., Middletown, Conn., to Block Island, R. I., will that of the line of eleven digits of obscuration on the north limb of the sun.

"As sixty-three years have passed since the occurrence of the last annular eclipse in New England, and as in the last forty-six years of the present century only one more will take place, it is not doubted that the one of May 26th will be viewed with interest by every spectator; but it is hoped that those observers, within the limits of the ring, who may be provided with a good telescope, will give particular attention to the singular appearances which so often have been noticed at the second and third contacts, and which, in consequence of having been minutely described by the late Mr. Bailly, are known by his name, especially as there is some reason for the suspicion that these beads, &c. may be seen or not, at the pleasure of the observer, according as he employs a screen colored red or green.

"In the eclipse of February 12, 1831, which was viewed by the writer at the light-house on Monomoy Point, off Chatham, with a red screen, these beads were, just before the formation of the ring, so very conspicuous, that it was difficult to determine with precision when it actually took place, whilst in that which was annular in Washington in September, 1838, and that which was total near Savannah in November, 1834, these appearances could not be perceived by him, although carefully looked for through a screen composed of two glasses, one shaded light red, the other light green.

"Indeed, it is particularly desirable that at some places there will be two observers furnished with telescopes of nearly the same optical power, but with screens colored green and red, who, after the second contact, shall exchange their instruments for their observations on the third, and shall note carefully the appearances and phenomena by which each contact is attended.

"The elements of the moon used for the following computations (except the parallax and semidiameter) are the mean of the quantities deduced from the tables of Damoiseau and Burckhardt. Those of the latter were taken from the English and French Nautical Almanacs, but those of Damoiseau were computed for May 26th, 6, 8, 10, and 12 hours of Paris, and thence interpolated for every hour of the meridian of Greenwich. Whilst the difference of the tables in latitude is small, or about a second and a half, in longitude it is very considerable, or eleven seconds. For the parallax, that of Burckhardt was preferred, as corrected by Mr. Adams, one of the distinguished discoverers of the planet Neptune, who, in a memoir affixed to the Nautical Almanac for 1856, appears to have thoroughly investigated the subject.

Path of the Central Eclipse of the Sun over the Earth, Friday, May 26, 1854, *according to the Tables of Damoiseau and Burckhardt, for every Fifth Minute whilst crossing the North Pacific Ocean, and for every Minute of the Remainder of the Time of its Continuance on the Earth.*

Mean Time at Greenwich.

Mean Time Gr.	Eclipse Central in		Mean Time Gr.	Eclipse Central in	
	Lat. North.	Long. West.		Lat. North.	Long. West.
h. m. s.	° ′	° ′	h. m. s.	° ′	° ′
6 54 55	6 38	197 7	8 30 0	41 5	144 40
55 0	7 23	195 22	35 0	42 3	142 54
55 2	7 38	194 34	40 0	42 58	141 4
55 6	7 59	193 46	45 0	43 50	139 11
6 57 30	11 18	187 11	50 0	44 39	137 13
7 0 0	13 11	183 18	55 0	45 26	135 11
5 0	16 12	178 35	*8 55 55	45 34.1	134 47.6
10 0	18 37	174 43	9 0 0	46 10	133 2.9
15 0	20 45	171 40	5 0	46 50	130 50.0
20 0	22 40	169 15	10 0	47 27	128 30.3
25 0	24 26	167 0	15 0	48 0.5	126 3.5
30 0	26 5	164 57	16 0	48 6.7	125 33.4
35 0	27 39	163 2	9 17 0	48 12.8	125 3.0
40 0	29 8	161 14			
45 0	30 33	159 30	*Washington Territory.*		
50 0	31 55	157 50	9 18 0	48 18.7	124 32.3
7 55 0	33 14	156 12	19 0	24.4	124 1.3
8 0 0	34 29	154 35	20 0	30.0	123 30.1
5 0	35 41	152 58	21 0	35.4	122 58.5
10 0	36 51	151 21	22 0	40.6	122 26.6
15 0	37 58	149 44	23 0	45.7	121 54.3
20 0	39 3	148 5	24 0	50.5	121 21.7
8 25 0	40 5	146 24	9 25 0	48 55.2	120 48.9

* On the meridian of the place.

Mean Time Gr. h.	m.	s.	Eclipse Central in Lat. North. ° ′	Eclipse Central in Long. West. ° ′
9	26	0	48 59.7	120 15.8
British Oregon.				
9	27	0	49 4.0	119 42.4
	28	0	8.1	119 8.6
	29	0	12.0	118 34.5
	30	0	15.7	118 0.0
	31	0	19.2	117 25.1
	32	0	22.5	116 49.8
	33	0	25.6	116 14.2
	34	0	28.5	115 38.2
	35	0	31.1	115 1.9
	36	0	33.5	114 25.2
	37	0	35.7	113 48.2
	38	0	37.6	113 10.7
	39	0	39.3	112 32.8
	40	0	40.8	111 54.6
	41	0	42.0	111 16.0
	42	0	43.0	110 36.9
	43	0	43.7	109 57.4
	44	0	44.1	109 17·5
	*45	0	44.3	108 37.1
	46	0	44.2	107 56.3
	47	0	43.8	107 15.0
	48	0	43.1	106 33.2
	49	0	42.0	105 50.9
	50	0	40.6	105 8.1
	51	0	39.0	104 24.9
	52	0	37.0	103 41.1
	53	0	34.7	102 56.8
	54	0	32.0	102 11.9
	55	0	28.9	101 26.4
	56	0	25.5	100 40.4
	57	0	21.7	99 53.8
	58	0	17.5	99 6.5
9	59	0	12.9	98 18.6
10	0	0	7.9	97 30.1
	1	0	49 2.5	96 41.0
	2	0	48 56.6	95 51.1
	3	0	50.2	95 0.4
10	4	0	48 43.3	94 8.9
N. E. Corner of Minnesota Terr.				
10	5	0	48 35.9	93 16.6
	6	0	28.0	92 23.2
	7	0	19.5	91 28.8
10	8	0	48 10.4	90 33.5

Mean Time Gr. h.	m.	s.	Eclipse Central in Lat. North. ° ′	Eclipse Central in Long. West. ° ′
Isle Royale, Lake Superior.				
10	9	0	48 0.7	89 37.3
Lake Superior.				
10	10	0	47 50.2	88 40.0
	11	0	38.9	87 41.4
	12	0	27.0	86 41.5
10	13	0	47 14.3	85 40.1
Canada West.				
10	14	0	47 0.9	84 37.2
	15	0	46 46.6	83 32.6
	16	0	31.3	82 26.3
	17	0	46 14.8	81 17.9
	18	0	45 57.1	80 7.2
	19	0	38.0	78 53.9
	20	0	45 17.5	77 37.6
	21	0	44 55.3	76 17.8
	21	15	49.5	75 57.2
10	21	30	44 43.5	75 36.4
State of New York.				
10	21	45	44 37.4	75 15.3
	22	0	31.2	74 53.9
	22	15	24.8	74 32.3
	22	30	18.3	74 10.3
10	22	45	44 11.6	73 48.0
Lake Champlain.				
10	23	0	44 4.8	73 25.4
State of Vermont.				
10	23	15	43 57.8	73 2.4
	23	30	50.6	72 39.0
10	23	45	43 43.3	72 15.3
State of New Hampshire.				
10	24	0	43 35.7	71 51.2
	24	15	27.9	71 26.7
10	24	30	43 19.9	71 1.8
State of Maine.				
10	24	45	43 11.6	70 36.2
Atlantic Ocean.				
10	25	0	43 3.2	70 10.1

* Greatest north latitude of the central path.

Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.	Mean Time Gr.	Eclipse Central in Lat. North.	Eclipse Central in Long. West.
h. m. s.	° '	° '	h. m. s.	° '	° '
10 26 0	42 26.4	68 18.2	10 30 0	37 54.2	55 58.6
27 0	41 43.7	66 13.9	30 12	37 5.7	53 56.7
28 0	40 52.4	63 48.9	30 15	36 41.8	52 57.3
10 29 0	39 45.4	60 47.5	10 30 16.1	36 17.4	51 56.8

Duration of the central eclipse on the earth, $3^{h.}$ $41^{m.}$ $21^{s.}.1$.

According to the Tables of Damoiseau and Burckhardt, the eclipse at the following places will be *annular*, and take place as follows, in mean time of the respective places: —

	Boston.	Brunswick, Me.	Cambridge Obs.
	° ' "	° '	° ' "
Latitude,	42 21 23	43 53	42 22 48
Longitude,	71 3 37	69 55	71 7 30
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 27 12	4 30 47	4 26 52.5
Formation of the Ring,	5 40 28	5 43 10	5 40 8.6
Least distance of centres,	41 27	44 21	41 8.8
Rupture of the Ring,	5 42 27	5 45 32	5 42 9.1
End of the Eclipse,	6 47 33	6 50 8	6 47 16.0
Duration of the Ring,	1 59	2 22	2 0.5
" " Eclipse,	2 20 21	2 19 21	2 20 23.5
At least distance. Distance of north limbs,	7.25"	92.66"	7.37"
At least distance. Distance of centres,	44.43	40.94	44.30
At least distance. Distance of south limbs,	96.11	10.78	95.98
Point of beginning,	150.5°	151.5°	150.5°
" end,	34.0	38.1	34.0

	Concord, N. H.	Hanover, N. H.	Middlebury, Vt.
	° ' "	° ' "	° '
Latitude,	43 12 30	43 42 26	44 0
Longitude,	71 29	72 16 45	73 10
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 24 8	4 19 42.4	4 15 3
Formation of the Ring,	5 36 43	5 32 41.0	5 28 32
Least distance of centres,	38 38	34 38.6	30 30
Rupture of the Ring,	5 40 32	5 36 36.2	5 32 28
End of the Eclipse,	6 45 0	6 41 25.4	6 37 42
Duration of the Ring,	3 49	3 55.2	3 56
" " Eclipse,	2 20 52	2 21 43.0	2 22 39
At least distance. Distance of north limbs,	39.61"	50.66"	51.33"
At least distance. Distance of centres,	11.91	0.66	0.19
At least distance. Distance of south limbs,	63.43	51.98	50.99
Point of beginning,	150.8°	150.7°	150.5°
" end,	35.5	36.0	35.9

	Ogdensburg, N. Y.	Portsmouth, N. H.	Scarboro' Harbor.
	° ′ ″	° ′ ″	° ′ ″
Latitude,	44 42 0	43 4 35	48 21 49
Longitude,	75 31 30	70 45 18	124 37 12
	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 2 40	4 27 47	11 22 52
Formation of the Ring,	5 17 29	5 39 55	0 57 11
Least distance of centres,	19 28	41 52	0 59 26
Rupture of the Ring,	5 21 26	5 43 47	1 1 40
End of the Eclipse,	6 27 46	6 47 54	2 33 41
Duration of the Ring,	3 57	3 52	4 29
" " Eclipse,	2 25 6	2 20 7	3 10 49
At least { of north limbs,	50.80″	44.32″	46.48″
distance. { of centres,	0.16	7.35	3.37
Distance { of south limbs,	50.48	59.02	39.74
Point of beginning,	149.9°	150.9°	101.4°
" end,	35.6	35.1	32.0

At the following places the eclipse will not be annular. The obscuration at Halifax, N. S., Charlottetown, P. E. I., and Montreal, being on the southern side of the sun, and at the other places on the northern.

	Charlottetown, P. E. Island.	Georgetown Obs., D. C.	Halifax, Nova Scotia.	Middletown Obs., Conn.
	° ′	° ′ ″	° ′ ″	° ′ ″
Latitude North,	46 14	38 54 26	44 39 20	41 33 8
Longitude West,	63 8	77 4 33	63 26 8	72 38 30
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 59 31	4 2 33.2	4 59 52.8	4 20 39.6
Greatest obscuration,	6 9 4	5 19 45.2	6 9 47.9	5 35 43.9
End of Eclipse,	7 12 6	6 27 28.8	7 12 59.0	6 42 21.4
Duration,	2 12 35	2 24 55.6	2 13 6.2	2 21 41.8
Point of beginning,	154.5°	147.1°	153.7°	149.6°
" end,	48.1	21.8	44.8	31.1
Digits eclipsed,	10.147	9.814	10.594	11.013

	Nantucket Obs., Mass.	New York C. H., N. Y.	Philadelphia Observatory.	Portland, Oregon.
	° ′ ″	° ′ ″	° ′ ″	° ′
Latitude North,	41 16 56	40 42 40	39 57 9	45 30.1
Longitude West,	70 5 40	74 0 30	75 10 0	122 27.5
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 33 8.8	4 15 8.9	4 10 31.8	11 31 59
Greatest obscuration,	5 46 46.0	5 30 55.8	5 26 48.8	1 11 10
End of Eclipse,	6 52 16.4	6 37 55.1	6 34 6.9	2 46 57
Duration,	2 19 7.6	2 22 46.2	2 23 35.1	3 14 58
Point of beginning,	150.3°	148.9°	148.2°	97.9°
" end,	32.6	28.2	25.6	22.0
Digits eclipsed,	11.173	10.640	10.306	10.675

	Providence Obs., R. I.	San Francisco, California.	Toronto Obs., Canada West.	Williamstown Obs., Mass.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Latitude North,	41 49 32	37 47 36	43 39 24	42 42 49
Longitude West,	71 24 15	122 26 48	79 21 30	73 12 37
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Eclipse begins,	4 26 14.6	11 25 3	3 44 40.6	4 16 26.0
Greatest obscuration,	5 40 38.6	1 3 59	5 3 50.0	5 31 54.5
End of Eclipse,	6 46 47.1	2 45 55	6 13 50.4	6 38 58.2
Duration,	2 20 32.5	3 20 52	2 29 9.8	2 22 32.2
	°	°	°	°
Point of beginning,	150.2	76.2	148.3	150.0
" end,	32.7	2.8	30.6	33.2
Digits eclipsed,	11.207	8.123	11.059	11.301

At *Eastham* Church, Cape Cod, Mass., in Lat. 41° 50′ 26″, Long. 69° 58′ 40″, the least distance of the centres (51″.81) will take place at $5^{h.}\ 46^{m.}\ 31^{s.}$; diff. of semidiameters 51″.94; from which it appears that the line of the southern limit of the ring passes on to the Atlantic about two miles south of Nausett lights, or in Lat. 41° 49′ 37″, Long. 69° 56′ 50″.

At *Montreal*, Canada, Lat. 45° 31′, Long. 73° 35′, the least distance, 62″.3, will be at $5^{h.}\ 26^{m.}\ 40^{s.}$; and as the difference of the semidiameters will be 51″.5 only, the eclipse will not be annular there, but probably will be so in the southwestern extremity of Montreal Island.

The village of Saratoga Springs, N. Y., Lat. 43° 3′, Long. 73° 43′, appears to be situated exactly under the line of the southern limit of the ring, as the least distance of the centres (51″.2), which occurs at $5^{h.}\ 29^{m.}.3$, is, according to the tables, the same as the difference of the semidiameters.

The difference between the *absolute* or Greenwich times of the beginning at Georgetown, New York, Boston, Brunswick, Charlottetown, &c., is quite small, or less than two minutes, or from $9^{h.}\ 10^{m.}\ 27^{s.}$ to $9^{h.}\ 12^{m.}\ 3^{s.}$ The time at any other place between them, and near the Atlantic, may therefore be easily ascertained with a good degree of accuracy, and without a direct computation, by subtracting its longitude from about $9^{h.}\ 11^{m.}$, and in this manner the time of the beginning at the following cities and towns was ascertained. The angle of the point at which the first impression will be made on the sun, or at which the eclipse will commence, is reckoned from the vertex to the right hand, and that at which the obscuration will end, from the vertex to the left (except at San Francisco, where it is also to the right), as seen through an *erect* telescope. For one that inverts, it is necessary to add 180°.

At those places marked with an asterisk, the eclipse will be annular.

Place.	Eclipse begins. P. M.	Angle from Vertex.	Place.	Eclipse begins. P. M.	Angle from Vertex.
	h. m.	°		h. m.	°
Albany, N. Y.,	4 14.0	150	N. Bedford, Mass.,	4 28.6	150
Amherst, Mass.,	4 20.2	150	*Newburyp't, Ms.,	4 27.5	151
*Andover, Mass.,	4 26.4	151	N. Haven, Conn.,	4 19.5	149
Annapolis, Md.,	4 5.0	148	Newport, R. I.,	4 27.0	150
Baltimore, Md.,	4 4.5	147	Norwich, Conn.,	4 23.5	150
Bangor, Me.,	4 36.0	153	*Plattsburg, N.Y.,	4 12.2	150
Burlington, N. J.,	4 11.7	148	Plymouth, Mass.,	4 29.3	150
*Burlington, Vt.,	4 14.3	151	*Portland, Me.,	4 29.7	151
*Dover, N. H.,	4 27.1	151	Princeton, N. J.,	4 12.5	148
Eastport, Me.,	4 43.5	153	*Provincetown,Ms.,	4 31.5	151
*Exeter, N. H.,	4 27.0	151	*Salem, Mass.,	4 27.6	151
*Gloucester, Mass.,	4 28.0	151	Springfield, Mass.,	4 20.5	150
*Lowell, Mass.,	4 25.5	151	Trenton, N. J.,	4 12.1	148
Montreal, C. E.,	4 11.3	151	West Point, N. Y.,	4 14.6	149
Newark, N. J.,	4 14.5	149	Worcester, Mass.,	4 24.1	150

Elements of the Eclipse. Mean Time at Greenwich.

Hour.	⊙'s Longitude.	⊙'s Lat.	⊙'s Right Asc.	Declination.	Semidiam.	Sid. Time.
	° ′ ″	″	° ′ ″	° ′ ″	′ ″	h. m. s.
5	65 3 26.60	N.0.05	63 6 54.62	21 9 35.18	15 48.91	4 15 44.14
6	5 50.55	.06	9 26.47	10 1.08	48.90	15 54.00
7	8 14.50	.06	11 58.32	10 26.94	48.89	16 3.86
8	10 38.45	.07	14 30.19	10 52.77	48.89	16 13.71
9	13 2.40	.08	17 2.07	11 18.56	48.88	16 23.57
10	15 26.35	.08	19 33.97	11 44.31	48.87	16 33.43
11	17 50.30	.09	22 5.87	12 10.02	48.87	16 43.28
12	65 20 14.24	N.0.09	63 24 37.79	21 12 35.69	15 48.86	4 16 53.14

⊙'s Horizontal Parallax, 8″.46; Obliquity, 23° 27′ 34″.1; Ellipticity, $\frac{1}{300}$th.

Lunar Elements by Burckhardt and Damoiseau.

Hour.	Moon's Longitude.		B. greater, D. less, by	Moon's Latitude North.		B. greater, D. less, by	Adams's Moon's Eq. Par.	Adams's Semidiameter.
	° ′ ″	′ ″	″	′ ″	′ ″	″	′ ″	′ ″
5	63 18 22.31	30 9.36	5.36	10 56.34	2 47.37	0.82	54 34.94	14 54.16
6	63 48 31.67	30 8.49	5.34	13 43.71	2 47.19	0.73	34.17	53.95
7	64 18 40.16	30 7.63	5.36	16 30.90	2 47.00	0.67	33.41	53.74
8	64 48 47.79	30 6.79	5.43	19 17.90	2 46.82	0.63	32.66	53.54
9	65 18 54.58	30 5.98	5.51	22 4.72	2 46.64	0.62	31.91	53.33
10	65 49 0.56	30 5.21	5.60	24 51.36	2 46.44	0.63	31.16	53.13
11	66 19 5.77	30 4.45	5.67	27 37.80	2 46.25	0.62	30.43	52.93
12	66 49 10.22		5.70	30 24.05		0.59	54 29.70	14 52.73

Hour.	Moon's Right Ascension.		Moon's Declination.		Damoiseau's Moon's Eq. Par.	Damoiseau's Semidiameter.
	° ′ ″	′ ″	° ′ ″	′ ″	′ ″	′ ″
5	61 14 5.22	31 9.53	21 0 48.77	8 28.01	54 33.58	14 52.49
6	61 45 14.75	31 12.26	9 16.78	8 22.06	32.82	52.28
7	62 16 27.01	31 14.98	17 38.84	8 16.06	32.07	52.07
8	62 47 41.99	31 17.62	25 54.90	8 10.01	31.32	51.87
9	63 18 59.61	31 20.32	34 4.91	8 3.92	30.58	51.67
10	63 50 19.93	31 23.01	42 8.83	7 57.81	29.86	51.47
11	64 21 42.94	31 25.68	50 6.64	7 51.67	29.16	51.28
12	64 53 8.62		21 57 58.31		54 28.51	14 51.10

Three hundred and ninety-seventh meeting.

March 28, 1854. — SEMI-MONTHLY MEETING.

The VICE-PRESIDENT, and afterwards the PRESIDENT, in the chair.

The Corresponding Secretary read a letter from the Trustees of the Astor Library, acknowledging the reception of Vol. V. Part I. of the Academy's Memoirs, and Vols. II. and III. (as far as published) of the Proceedings; also a letter from Rev. Charles Brooks on the Weather Law.

Professor Lovering exhibited a bioscope; an optical instrument for giving the motions of life to pictures, and illustrating the great advancement of optical science. This instrument combines the three important modern discoveries of the daguerreotype, the stereoscope, and the phenakistiscope. The daguerreotype gives a perfect picture, without solidity or motion; the stereoscope suggests the idea of solidity without motion; the phenakistiscope imparts life by motion. The bioscope obtains perfect figures from the daguerreotype. By a stereoscopic arrangement of mirrors adapted to both eyes, the figures acquire solidity; and by the revolution of the phenakistiscope, the figures exhibit the motions of life. It requires some practice to see all that the instrument is capable of showing; and the combination admits of considerable improvement.

Professor W. B. Rogers made a communication on the natural coke found in the vicinity of Richmond, Virginia. This coke is almost entirely free from volatile or bituminous matters, being less puffy than ordinary coke, but less compact than anthracite. In the vicinity of the coal-seams are dikes of trap-rock. One hundred and twenty feet below the surface there is a bed of trap-rock, twenty-five feet in thickness; below this is a clay-slate, almost vitrified, commonly called "basalt," which has assumed a columnar crystallization; below this are alternating beds of sandstones and slates. Then, at the depth of sixty feet below the trap, there are ten or twelve feet of this coke, having occasional traces of vegetable remains, and at the bottom of the bed having a small amount of bituminous matter. Twenty feet below this is a half-coky coal, and fifteen feet below this, the ordinary bituminous coal of the country. These strata plainly indicate the graduation and diminution of the heating action in a downward direction. It is very curious, that in the beds of carboniferous slate above the trap there is no indication of this metamorphic action; there are even seams of coal above it; the veins of injected material must have been thrown up from beneath, the heating action extending from the interposed trap in a downward direction. This series of strata is therefore interesting, as proving that there were periods of igneous activity during the deposition of these formations.

Three hundred and ninety-eighth meeting.

April 11, 1854. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Lovering exhibited a model of an instrument for producing great velocities in experimental physics, particularly in optics. The motion is produced by a spring acting upon a train of wheels, and may be very suddenly diminished or increased by friction. With it were performed several experiments by the rapid revolution of variously painted cards; as of mixing the prismatic colors, and any two complementary tints or colors to form white. The instrument is of practical use to painters in mixing colors, as the effect of mixing any two colors may be at once seen. Dove, of Berlin, has used this instrument in showing that, when the eye has rested for a certain time on a bright color and then is turned to a white surface, the retina becomes partly insensible to the first color and feels more strongly its complementary color. These experiments were also shown.

Dr. Hayes exhibited some of the juice of the India-rubber tree, preserved from decomposition by a patent process. By the addition of a weak alkali to the recent juice, a substance prone to acetous fermentation is so changed that the formation of acid is prevented. This has led to many new applications of this useful substance. He exhibited specimens of perfectly pure India-rubber obtained from this milky juice; the consistence of the latter is between that of milk and cream; it yields from 48 to 52 per cent. of solid India-rubber. What he wished particularly to draw the attention of the Academy to was the fact, that this substance, in its normal state, is perfectly transparent; it is curious that from this entirely opaque fluid a transparent India-rubber should be obtained by simple desiccation. He exhibited a glass vessel coated inside and outside with this material, which did not in the least diminish the transparency of the glass, and was recognizable only by the touch; he had found that a considerable number of coatings did not diminish the transparency.

Dr. Kneeland read an abstract of the views of Messrs. Nott and Gliddon, as given in a work just published, entitled "Types of Mankind," in which the strongest arguments are given in favor of the theory of the original diversity of the human races; based in a great measure on the proofs derived from the Egyptian monuments, that at least four human races have remained distinct in and around the valley of the Nile from ages anterior to 3,500 years B. C., and consequently long anterior to any alphabetic chronicles, sacred or profane; the first part of the book ending with the conclusion "that there exists a *genus* HOMO embracing many primordial types or 'species.' " The second and third parts of the work are upon those portions of Scripture which bear upon the origin of mankind.

Dr. A. A. Gould alluded to the alleged fossil human bones from the upper part of Florida, and expressed the opinion of himself, and others who had examined the localities, that they had no claim to be considered as fossil bones.

The Corresponding Secretary read a letter from the Geological Society of London, acknowledging the reception of Vol. V. Part. I. of the Academy's Memoirs. Also letters from the Verein für Vaterlaendische Naturkunde, at Würtemberg, and the Société des Sciences Naturelles de Cherbourg, requesting an exchange of publications with the Academy; the latter Society had already sent one volume of its publications, in octavo.

Three hundred and ninety-ninth meeting.

April 25, 1854. — SEMI-MONTHLY MEETING.

The PRESIDENT in the chair.

Letters were read from the Ethnological Society of London, Rear-Admiral Smyth, and the Breslau Akademie der Naturforscher, acknowledging the reception of Vol. V. Part I. of the Academy's Memoirs; letters from the K. K. Geologische Reichsanstalt of Vienna, and the Académie Royale des Sciences de Stockholm, acknowledging the reception, the former of Vol. IV. Part. II., and the latter of Vol. V. Part I. of the Academy's Memoirs, and transmitting also donations of their publications in exchange; and letters from the Royal Institution of London, the Akademie der Wissenschaften of Vienna, and the Royal Danish Academy of Sciences of Copenhagen, presenting their publications.

Professor Horsford presented the following paper, offered to the Academy at a former meeting, and since revised and modified, " On the Value of the different Kinds of Prepared Vegetable Food," by John Dean.

"The following investigation, carried on in the laboratory of the Lawrence Scientific School, at the suggestion of Professor Horsford and under his direction, had for its object the determination of the nutritive values of the several kinds of prepared vegetable food found in our markets, particularly those allied in constitution to the starches, and is based on the amount of nitrogen contained in each. It is a well-known fact in physiological chemistry, that food to be nutritious must contain the ingredients necessary for the formation of the tissues and bones, as well as for the production of heat and formation of fat. The elements of which the tissues are formed are constantly undergoing changes, and the matter which at one time sustains vital activity is excreted, and replaced by new matter derived by means of the blood from the food. It is therefore necessary that food should contain the same substances or elements which are found in the different parts of the animal frame. These are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, and some inorganic bases and salts. It is evident at a glance that they may be divided immediately into two classes, organic and inorganic. It is with the former class that we have chiefly to deal in the following pages. The organic class may be subdivided into bodies containing nitrogen, — with which are commonly associated, besides carbon, hydrogen, and oxygen, small quantities of sulphur and phosphorus, — and bodies containing no nitrogen, and conforming nearly to the formula of starch, $C_{12} H_{10} O_{10}$. We have thus divided the elements composing the animal frame, and consequently the elements of food, into three classes, each of which plays its individual part in the animal organism; — 1st. Bodies containing nitrogen, nitrogenous ingredients of food; such are albumen, gluten, &c. 2d. Non-nitrogenous bodies, starch, sugar, &c. 3d. Inorganic salts. These, as is well known, are of use in the following manner. The nitrogenous bodies enter into the composition of the tissues. Those containing no nitrogen contribute to form fat, and from their solution in the blood produce heat, their carbon being gradually burned by means of the oxygen inhaled by the lungs. Lastly, the inorganic salts assist in forming the bones, and enter into the composition of every organ of the body. Their values for the first-mentioned purpose have been the object of the following determinations.

"In regard to the specimens analyzed, they were taken in the marketable condition, and as it is often the case that tapioca, sago, and arrowroot are largely adulterated, care was taken to procure them of as good a quality as possible. The arrowroot, which is the most extensively adulterated of the three, was tested both by means of the vapor of iodine and the microscope, so that no doubt might exist of its being a pure article.

" The determinations were made in the following manner. The different specimens were dried in watch-glasses at a temperature of 100° C. (212° F.), and were all dried for the water determinations in their market condition, with the exception of maccaroni, which seemed likely to offer so much resistance to the escape of moisture, that it was pulverized previously to drying. They were then all pulverized, thoroughly dried at the same temperature (100° C.), and the determinations of carbon, hydrogen, and nitrogen made. The combustions for carbon and hydrogen were effected in the usual manner with oxide of copper, the portion of oxide of copper at the extremity of the tube being intimately mixed with very finely pulverized chlorate of potassa. The nitrogen was determined as ammonio-chloride of platinum by ignition with soda-lime, according to the method of Varrentrapp and Will. As the amount of nitrogen was exceedingly small in most of the specimens, it was supposed that the chloride of ammonium produced in the hydrochloric acid employed, by the absorption of ammonia from the air, might produce a perceptible effect upon the results of the analyses. Coincident determinations were therefore made with the hydrochloric acid in every analysis, by evaporating portions of acid and bichloride of platinum equal to those actually employed in determining the results of the combustions, collecting the precipitate on a weighed filter as usual, washing with alcohol, &c. It was found, however, in every case, that the filter lost more from washing with alcohol than it gained by the precipitate; it was therefore necessary to make a small addition, generally about 0.0014 grm. to the amount of ammonio-chloride of platinum obtained from the combustion. In making a statement of the results, the nitrogen was taken as the basis of the calculation; carbon, hydrogen, oxygen, and sulphur were distributed to it according to the proportions indicated by the formulæ of nitrogenous bodies. Albumen and gluten agree with each other so nearly in constitution, as given in the analyses of Scheerer (*Ann. der Chem. und Pharm.*, XL. 38), of Mulder, and of Rüling (*Ann. der Chem. und Pharm.*, LVIII. 310), that a single formula has been taken, namely, that of Mulder: —

Carbon	= 53.5
Hydrogen	= 7.0
Nitrogen	= 15.5
Oxygen	= 22.0
Sulphur	= 1.6
Phosphorus	= 0.4
	100.0

The percentage of phosphorus being so small, it has been neglected in the estimations.

" The carbon computed by the foregoing formula, deducted from the total amount, afforded a basis for calculating the starch, and as the numerous experiments of Horsford and Krocker have shown so conclusively that the amount of starch may be accurately calculated in this way, no doubt can be reasonably felt with regard to the justice of so doing. Hydrogen and oxygen are accordingly distributed to the carbon, according to the formula $C_{12} H_{10} O_{10}$. This being done, a balance of hydrogen remained in every case. It was conceived that this was probably due to the fact that the starches cannot be deprived of all their moisture at 100° C.; part is also probably owing to moisture absorbed by the starch whilst weighing, as starch dried at 100° C. is exceedingly hygroscopic, " taking up in a few days exposed to the air 35 per cent. of moisture." (Knapp.) This hydrogen was therefore supplied with oxygen according to the formula of water. It will be seen by consulting the results, that the amount of moisture thus obtained is often quite large, and has a very considerable effect upon the averages. It is on this account, perhaps, somewhat to be regretted that the moisture was not determined at 120° or 125° C., instead of 100° C.

" No. I. CORN-STARCH, No. 1.

" Corn-starch is prepared from maize or Indian corn, by the aid either of the ordinary method of steeping and fermenting, or else by steeping the corn, both before and after grinding, in a caustic or carbonated alkaline lye, the gluten remaining dissolved in the lye. This specimen was in the state of fine powder.

I. 0.869 grm. gave at 100° C. 0.1392 grm. loss.
II. 1.127 grm. dried at 100° C. left 0.0038 grm. ash.
III. 4.0347 grm. dried at 100° C. left 0.0133 grm. ash.
IV. 0.3124 grm. gave 0.5017 grm. CO_2 and 0.1857 grm. HO.

V. 0.4468 grm. gave 0.7246 grm. CO_2 and 0.271 grm. HO.
VI. 0.7073 grm. gave 0.0137 grm. $NH_4Cl. PtCl_2$.
VII. 1.9168 grm. gave 0.032 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.79	44.22	44.01
Hydrogen	6.60	6.74	6.67
Nitrogen	0.12	0.10	0.11
Ash	0.33	0.33	0.33
Water	16.01		16.01

Estimated according to the formulæ given, we have

Nitrogenous constituents,	Nitrogen	0.11	
	Carbon	0.38	
	Hydrogen	0.05	
	Oxygen	0.16	
	Sulphur	0.01	
			0.71
Non-nitrogenous constituents,	Carbon	43.63	
	Hydrogen	6.06	
	Oxygen	48.49	
			98.18
Water not expelled at 100° C.	Hydrogen	0.56	
	Oxygen	4.48	
			5.04
	Ash		0.33
			104.26

Reduced to an average percentage we obtain,—

	Dried at 100° C.	Fresh.
Nitrogenous constituents	0.69	0.58
Inorganic "	0.32	0.26
Starch, sugar, &c.	94.16	79.09
Water not expelled at 100° C., and accidental moisture	4.83	4.06
Water		16.01
	100.00	100.00

"No. II. CORN-STARCH, No. 2.

"This specimen differed from No. 1 in being made into lumps in the state in which wheat-starch is usually sold; it yielded nearly three times as much nitrogen as No. 1, and was therefore not so pure a starch, but better fitted for the purposes of nutrition. Of its manufacture, I was unable to obtain any information.

I. 3.1531 grm. lost at 100° C. 0.3748 grm.
II. 2.508 grm. dried at 100° C. gave 0.011 grm. ash.
III. 0.3189 grm. gave 0.508 grm. CO_2 and 0.187 grm. HO.
IV. 1.2677 grm. gave 0.0761 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.
Carbon	43.44
Hydrogen	6.51
Nitrogen	0.38
Ash	0.43
Water	11.88

Estimated as above, we have

Nitrogenous constituents,	Nitrogen	0.38	
	Carbon	1.31	
	Hydrogen	0.17	
	Oxygen	0.53	
	Sulphur	0.04	
			2.43
Non-nitrogenous constituents,	Carbon	42.13	
	Hydrogen	5.85	
	Oxygen	46.81	
			94.79
Water not expelled at 100° C.	Hydrogen	0.49	
	Oxygen	3.92	
			4.41
	Ash		0.43
			102.06

Reduced to an average percentage, we obtain

	Dried at 100° C.	Fresh.
Nitrogenous constituents	2.38	2.10
Inorganic "	0.42	0.37
Starch, sugar, &c.	92.88	81.84
Water not expelled at 100° C., and accidental moisture	4.32	3.81
Water		11.88
	100.00	100.00

"No. III. TAPIOCA.

"Tapioca is a modification of starch, being partially converted into gum by heating. It is prepared from the root of the *Jatropha manihot*, found in the West Indies, South America, and Africa. The roots are washed, reduced to pulp, and subjected to strong pressure, by which means they are deprived of nearly all their highly poisonous juice. As the active principle of this juice is volatile, it is entirely dissipated by baking the pulp upon iron plates. The pulp thus prepared is hard and friable, and is easily broken into lumps, which are laid in the sun to dry. In this state it is known by the name of *cassava.* It is purified by being stirred up with water and filtered through linen; the liquid is then boiled down over a fire, being constantly kept in agitation. As the water evaporates the starch thickens, and finally becomes granulated, when it must be dried over a stove. A tolerably good imitation of it is made by treating potato-starch in a similar manner.

I. 1.0577 grm. lost at 100° C. 0.1409 grm.
II. 1.383 grm. dried at 100° C. left 0.0016 grm. ash.
III. 3.8196 grm. dried at 100° C. left 0.0048 grm. ash.
IV. 0.3669 grm. gave 0.5896 grm. CO_2 and 0.214 grm. HO.
V. 0.3611 grm. gave 0.5774 grm. CO_2 and 0.2118 grm. HO.
VI. 2.3044 grm. gave 0.041 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.79	43.61	43.70
Hydrogen	6.48	6.51	6.49
Nitrogen	0.10		0.10
Ash	0.12	0.12	0.12
Water	13.32		13.32

Estimated in 100 parts, we obtain the following numbers:—

Nitrogenous constituents,	Nitrogen	0.10	
	Carbon	0.34	
	Hydrogen	0.04	
	Oxygen	0.13	
	Sulphur	0.01	
			0.62
Non-nitrogenous constituents,	Carbon	43.36	
	Hydrogen	6.02	
	Oxygen	48.19	
			97.57
Water not expelled at 100° C.	Hydrogen	0.43	
	Oxygen	3.44	
			3.87
	Ash		0.12
			102.18

Reduced to percentage, we obtain

	Dried at 100° C.	Fresh.
Nitrogenous constituents	0.61	0.53
Inorganic "	0.11	0.09
Starch, sugar, &c.	95.49	82.77
Water not expelled at 100° C., and accidental moisture	3.79	3.29
Water		13.32
	100.00	100.00

" No. IV. ARROWROOT.

" Arrowroot is a very pure starch, prepared in the West Indies from the roots of the *Marantha arundinacea* and *indica*. The starch is contained in the tubers, in numerous very minute cells. It has been cultivated with the greatest success upon the Hopewell estate, in the island St. Vincent, where it often grows to the height of three feet, and sends out tap-roots to the depth of eighteen inches; the preparation is as follows: — 'The carefully skinned tubers are washed, then ground in a mill, and the pulp washed in tinned copper cylindrical washing-machines. The fecula is subsequently dried in drying-houses. In order to obtain the fecula free from impurity, pure water must be used, and great care and attention paid in every step of the process. The skinning or peeling of the tubers must be performed with great nicety, as the cuticle contains a resinous matter, which imparts color and a disagreeable flavor to the starch. German-silver palettes are used for skinning the deposited fecula, and shovels of the same metal are used for packing the dried fecula. The drying is effected in pans covered by white gauze, to exclude dust and insects.' (Pereira.)

I. 4.4838 grm. lost at 100° C. 0.7404 grm.
II. 3.6005 grm. dried at 100° C. left 0.0077 grm. ash.
III. 0.3978 grm. gave 0.6325 grm. CO_2 and 0.2286 grm. HO.
IV. 0.3908 grm. gave 0.6209 grm. CO_2 and 0.2258 grm. HO.
V. 1.3125 grm. gave 0.03 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.37	43.33	43.35
Hydrogen	6.39	6.42	6.40
Nitrogen	0.14		0.14
Ash	0.21		0.21
Water	16.51		16.51

Estimated as above, we obtain

Nitrogenous constituents,	Nitrogen	0.14	
	Carbon	0.49	
	Hydrogen	0.06	
	Oxygen	0.19	
	Sulphur	0.01	
			0.89
Non-nitrogenous constituents,	Carbon	42.86	
	Hydrogen	5.95	
	Oxygen	47.63	
			96.44
Water not expelled at 100° C.	Hydrogen	0.39	
	Oxygen	3.12	
			3.51
	Ash		0.21
			101.05

Reduced to percentage, we obtain

	Dried at 100° C.	Fresh.
Nitrogenous constituents	0.88	0.73
Inorganic "	0.21	0.18
Starch, sugar, &c.	95.44	79.68
Water not expelled at 100° C., and accidental moisture	3.47	2.90
Water		16.51
	100.00	100.00

" No. V. Sago.

" Sago is a variety of starch extracted from the pith of palms, many species of which are capable of yielding it. Amongst these are *Sagus Rumphii*, *Cicas inermis* and *revoluta*, *Coryota urens*, *Borassus Gomato*, and several species of Zamia, Corypha, and Mauritia. The starch is obtained from the pith, which constitutes nearly the entire body of the stem of these palms. A single stem is said to yield three cwt. of sago. The stem is cleft open, and the starch collected, washed upon sieves, and purified by elutriation with water in vats; the granulation is performed by forcing the starch through sieves in such a manner that the lumps shall fall upon a hot plate of copper. Each lump is converted into paste, the granules of starch swell up and dry into the irregular, roundish masses, about the size of small shot, which constitute the sago in its market condition.

" Sago is sometimes fraudulently imitated with potato-starch, but this has a greater tendency to become pasty when boiled. 'The essential property of sago consists in its swelling up in hot water or soup without melting, the separate little lumps remaining entire, and forming translucent, stiffly gelatinous, but not slimy globules. Six varieties of sago are distinguished by Planche.' (Knapp.)

I. 3.118 grm. lost at 100° C. 0.4001 grm.
II. 2.5906 grm. dried at 100° C. left 0.005 grm. ash.
III. 0.3791 grm. gave 0.6052 grm. CO_2 and 0.2128 grm. HO.
IV. 0.3588 grm. gave 0.574 grm. CO_2 and 0.2063 grm. HO.
V. 1.1509 grm. gave 0.0256 grm. $NH_4Cl. PtCl_2$.
VI. 1.1313 grm. gave 0.026 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.53	43.63	43.58
Hydrogen	6.24	6.38	6.31
Nitrogen	0.12	0.14	0.13
Ash	0.19		0.19
Water	12.83		12.83

Estimated as before, we have

Nitrogenous constituents,	Nitrogen	0.13	
	Carbon	0.45	
	Hydrogen	0.06	
	Oxygen	0.18	
	Sulphur	0.01	
			0.83
Non-nitrogenous constituents,	Hydrogen	5.99	
	Carbon	43.13	
	Oxygen	47.92	
			97.04
Water not expelled at 100° C.	Hydrogen	0.26	
	Oxygen	2.08	
			2.34
	Ash		0.19
			100.40

Reduced to an average percentage, we obtain

	Dried at 100° C.	Fresh.
Nitrogenous constituents	0.83	0.72
Inorganic "	0.19	0.17
Starch, sugar, &c.	96.65	84.25
Water not expelled at 100° C., and accidental moisture	2.03	2.03
Water		12.83
	100.00	100.00

“ No. VI. Wheat-Starch.

“ This was introduced chiefly for the sake of comparing it with the other starches. All the principal facts regarding its manufacture are too well known to require enumeration.

I. 2.3346 grm. lost at 100° C. 0.2634 grm.
II. 1.8624 grm. dried at 100° C. left 0.0098 grm. ash.
III. 0.3758 grm. gave 0.6062 grm. CO_2 and 0.2165 grm. HO.
IV. 0.3502 grm. gave 0.5661 grm. CO_2 and 0.2098 grm. HO.
V. 1.7456 grm. gave 0.0516 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.99	44.08	44.04
Hydrogen	6.41	6.65	6.53
Nitrogen	0.18		0.18
Ash	0.53		0.53
Water	11.28		11.28

Estimated as before, we have

Nitrogenous constituents,	Nitrogen	0.18	
	Carbon	0.62	
	Hydrogen	0.08	
	Oxygen	0.25	
	Sulphur	0.02	
			1.15
Non-nitrogenous constituents,	Carbon	43.42	
	Hydrogen	6.03	
	Oxygen	48.24	
			97.69
Water not expelled at 100° C.	Hydrogen	0.42	
	Oxygen	3.36	
			3.78
	Ash		0.53
			103.15

Reduced to average percentage, we have

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	1.12	0.99
Inorganic	0.51	0.45
Starch, sugar, &c.	94.71	84.03
Water not expelled at 100° C. and accidental moisture	3.66	3.25
Water		11.28
	100.00	100.00

"No. VII. Rice Flour.

I. 1.5265 grm. lost at 100° C. 0.2139 grm.
II. 1.2604 grm. dried at 100° C. left 0.0063 grm. ash.
III. 0.4318 grm. gave 0.6924 grm. CO_2 and 0.2477 grm. HO.
IV. 0.347 grm. gave 0.5566 grm. CO_2 and 0.197 grm. HO.
V. 1.1169 grm. gave 0.2064 grm. $NH_4Cl.PtCl_2$.
VI. 0.6989 grm. gave 0.1577 grm. $NH_4Cl.PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.75	43.75	43.75
Hydrogen	6.37	6.30	6.33
Nitrogen	1.40	1.15	1.28
Ash	0.49		0.49
Water	14.01		14.01

Estimated according to the formula as before, we obtain

Nitrogenous constituents,	Nitrogen	1.28	
	Carbon	4.42	
	Hydrogen	0.58	
	Oxygen	1.82	
	Sulphur	0.13	
			8.23
Non-nitrogenous constituents,	Carbon	39.33	
	Hydrogen	5.46	
	Oxygen	43.69	
			88.48
Water not expelled at 100° C.	Hydrogen	0.29	
	Oxygen	2.32	
			2.61
	Ash		0.49
			99.81

Reduced to percentage, we obtain

	Dried at 100° C.	Fresh.
Nitrogenous constituents	8.24	7.09
Inorganic "	0.49	0.42
Starch, sugar, &c.	88.65	76.23
Water not expelled at 100° C. and accidental moisture	2.62	2.25
Water		14.01
	100.00	100.00

"No. VIII. Maccaroni.

"Maccaroni is a dough prepared from fine wheat-flour, made into a tubular form about the thickness of a goose-quill. It is prepared to most advantage from the hard Italian wheat, which is richer in gluten than the wheat of more northern countries. This is ground into a coarse flour by means of light millstones, and is made into a paste with hot water. The Italians pile up the pieces of dough one upon another, and tread it well with their feet for two or three minutes. When the dough is properly kneaded, it is placed in a cast iron cylinder, which is kept warm in order to render the dough thin and plastic; it is then forced through holes in the bottom of the cylinder, which give it the shape of fillets or ribbons, the edges of which are joined together, forming the paste into tubes. It is finally dried in the sun.

I. 2.7108 grms. lost at 100° C. 0.2684 grm.
II. 2.807 grms. dried at 100° C. left 0.0276 grm. ash.
III. 0.3666 grm. gave 0.6141 grm. CO_2 and 0.2169 grm. HO.
IV. 0.3452 grm. gave 0.5773 grm. CO_2 and 0.2048 grm. HO.
V. 1.015 grm. gave 0.2599 grm. $NH_4Cl. PtCl_2$.
VI. 1.1739 grm. gave 0.2856 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	45.69	45.58	45.64
Hydrogen	6.58	6.59	6.58
Nitrogen	1.60	1.49	1.55
Ash	0.98		0.98
Water	9.90		9.90

Estimated as above, we obtain

Nitrogenous constituents,	Nitrogen	1.55	
	Carbon	5.35	
	Hydrogen	0.70	
	Oxygen	2.20	
	Sulphur	0.16	
			9.96
Non-nitrogenous constituents,	Carbon	40.29	
	Hydrogen	5.59	
	Oxygen	44.77	
			90.65
Water not expelled at 100° C.	Hydrogen	0.29	
	Oxygen	2.32	
			2.61
	Ash		0.98
			104.20

Estimated in 100 parts, we have

	Dried at 100° C.	Fresh.
Nitrogenous constituents	9.56	8.61
Inorganic "	0.95	0.86
Starch, sugar, &c.	86.99	78.38
Water not expelled at 100° C., and accidental moisture	2.50	2.25
Water		9.90
	100.00	100.00

"No. IX. Prepared Potato.

"The specimen analyzed was finely divided, dried potato, prepared for transportation, use on sea-voyages, &c. Of the details of its manufacture, I was unable to obtain any information.

I. 2.3378 grms. lost at 100° C. 0.2354 grm.
II. 2.1046 grms. dried at 100° C. left 0.0842 grm. ash.
III. 0.4042 grm. gave 0.6415 grm. CO$_2$ and 0.221 grm. HO.
IV. 0.2933 grm. gave 0.4623 grm. CO$_2$ and 0.1614 grm. HO.
V. 0.6696 grm. gave 0.1800 grm. NH$_4$Cl. PtCl$_2$.
VI. 0.7431 grm. gave 0.1912 grm. NH$_4$Cl. PtCl$_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.28	42.99	43.14
Hydrogen	6.07	6.11	6.09
Nitrogen	1.67	1.60	1.63
Ash	4.00		4.00
Water	10.07		10.07

Estimated as before, we obtain

Nitrogenous constituents,	Nitrogen	1.63	
	Carbon	6.28	
	Hydrogen	0.73	
	Oxygen	2.31	
	Sulphur	0.16	
			11.11
Non-nitrogenous constituents,	Carbon	36.86	
	Hydrogen	5.12	
	Oxygen	40.95	
			82.93
Water not expelled at 100° C.	Hydrogen	0.24	
	Oxygen	1.92	
			2.16
	Ash		4.00
			100.20

Estimated in 100 parts, we have

	Dried at 100° C.	Fresh.
Nitrogenous constituents	11.09	9.97
Inorganic "	3.99	3.59
Starch, sugar, &c.	82.77	74.44
Water not expelled at 100° C., and accidental moisture	2.15	1.93
Water		10.07
	100.00	100.00

"No. X. FARINA.

"Farina is prepared both from corn and wheat, and is in rounded grains resembling sago in appearance, only smaller. Although I made many inquiries, I was unable to obtain any information respecting its preparation from the manufacturers. It is perhaps prepared by washing out a portion of the starch from the finely ground meal, and drying and granulating the residue. The specimen analyzed was prepared from corn. It seems to have less starch and about the same amount of nitrogenous ingredients as Indian-corn meal, an analysis of which by Professor Horsford (Phil. Mag., S. 3. XXIX. 365) gave as follows: Starch 84.90; nitrogenous ingredients 13.65. Farina gives: Starch 81.76; nitrogenous ingredients 13.61.

I. 3.794 grms. lost at 100° C. 0.3908 grm.
II. 3.403 grms. dried at 100° C. left 0.0176 grm. ash.
III. 0.341 grm. gave 0.5461 grm. CO_2 and 0.1988 grm. HO.
IV. 0.4322 grm. gave 0.6919 grm. CO_2 and 0.2583 grm. HO.
V. 0.4434 grm. gave 0.1506 grm. $NH_4Cl. PtCl_2$.

Corresponding in 100 parts to

	I.	II.	Average.
Carbon	43.67	43.66	43.66
Hydrogen	6.45	6.64	6.54
Nitrogen	2.12		2.12
Ash	0.51		0.51
Water	10.30		10.30

Estimated as before, we obtain

Nitrogenous constituents,	Nitrogen	2.12	
	Carbon	7.32	
	Hydrogen	0.96	
	Oxygen	3.00	
	Sulphur	0.21	
			13.61
Non-nitrogenous constituents,	Carbon	36.34	
	Hydrogen	5.05	
	Oxygen	40.37	
			81.76
Water not expelled at 100° C.	Hydrogen	0.53	
	Oxygen	4.24	
			4.77
	Ash		0.51
			100.65

Reduced to an average, we have

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	13.52	12.13
Inorganic "	0.51	0.46
Starch, sugar, &c.	81.23	72.86
Water not expelled at 100° C., and accidental moisture	4.74	4.25
Water		10.30
	100.00	100.00

1. *Tabular Results of Analyses.*

	Nitrogen.	Carbon.	Hydrogen.	Oxygen.	Sulphur.	Ash.
Corn-Starch, No. 1,	0.11	44.01	6.67	53.13	0.01	0.33
" No. 2,	0.38	43.44	6.51	51.26	0.04	0.43
Tapioca,	0.10	43.70	6.49	51.76	0.01	0.12
Arrowroot,	0.14	43.35	6.40	50.94	0.01	0.21
Sago,	0.13	43.58	6.31	50.18	0.01	0.19
Wheat-Starch,	0.18	44.04	6.53	51.85	0.02	0.53
Rice Flour,	1.28	43.75	6.33	47.83	0.13	0.49
Maccaroni,	1.55	45.64	6.58	49.29	0.16	0.98
Prepared Potato,	1.63	43.14	6.09	44.18	0.16	4.00
Farina,	2.12	43.66	6.54	47.61	0.21	0.51

2. *Tabular View of the Nitrogenous Constituents.*

	Nitrogenous Constituents.		Water.
	Dried at 100° C.	Fresh.	
Corn-Starch, No. 1,	0.71	0.60	16.01
" " " 2,	2.43	2.14	11.88
Tapioca,	0.62	0.53	13.32
Arrowroot,	0.89	0.73	16.51
Sago,	0.83	0.72	12.83
Wheat-Starch,	1.15	1.02	11.28
Rice Flour,	8.23	7.08	14.01
Maccaroni,	9.96	9.01	9.90
Prepared Potato,	11.11	9.98	10.07
Farina,	13.61	12.21	10.30

3. *Table for the Starch.*

	Dried at 100° C.	Fresh.
Corn-Starch, No. 1,	98.18	83.08
" " " 2,	94.79	83.75
Tapioca,	97.57	84.85
Arrowroot,	96.44	80.68
Sago,	97.04	84.61
Wheat-Starch,	97.69	87.01
Rice Flour,	88.48	76.06
Maccaroni,	90.65	82.04
Prepared Potato,	82.93	74.60
Farina,	81.76	73.39

4. *Table of Equivalents or Weights for an Equal of Nutritive Power.* — *Arrowroot at* 100.

	Dried at 100° C.	Fresh.
Corn-Starch, No. 1,	125.3	121.6
" " " 2,	36.6	34.1
Tapioca,	143.5	137.7
Arrowroot,	100.0	100.0
Sago,	107.2	101.4
Wheat-Starch,	77.4	72.1
Rice Flour,	10.8	10.3
Maccaroni,	8.9	8.1
Prepared Potato,	8.0	7.3
Farina,	6.5	5.9

"The tables given were all of them calculated from the direct results of the different analyses, and not from the average per cent. statements. By comparing the results of the determinations as given in the above tables, we shall arrive at the following conclusions.

"A much larger amount of starch is contained in all the specimens analyzed, than of nitrogenous constituents. Food, to be properly constituted, should contain the elements which support respiration and furnish fat, as well as those which form the tissues. We shall, however, see, by comparing tables 2 and 3, that the proportions of starch differ very much less when compared with each other, than the nitrogenous ingredients do. The proportions of starch in the first six and last four specimens are about equal to each other, whilst we have in Farina twenty times as great a quantity of nitrogenous constituents as in Corn-Starch No. 1, or Tapioca. I have, therefore, in the last table, given the nutritive powers of the different specimens based upon the amount of the nitrogenous constituents, the starch being nearly enough equal in all to compute their nutritive power upon the nitrogen alone. Arrowroot was taken as the standard. 127.5 parts of corn-starch are required to equal in nutritive power 100 parts of arrowroot, &c.

"We shall also see,—

"That the specimens analyzed may be divided into two classes, according to their relative quantity of nitrogen. The first of which will include the starches; the second, farina, maccaroni, rice flour, and prepared potato.

"That the members of the second class are very much better fitted for nutrition than those of the first class, farina being sixteen times as nutritious as arrowroot, and twenty-three times more nutritious than tapioca.

"That the members of the second class contain, with the exception of rice, less moisture than the first.

"That two specimens of corn-starch may differ from each other largely, one containing three times as much nitrogen as the other.

"That the members of the first group contain from one sixth to one ninth their total weight of moisture which may be expelled at 100° C.; those of the second, from one seventh to one tenth.

"With regard to the ashes we find,—

"That potato, dried at 100° C., gives over four times as much ash as any other specimen analyzed.

"That the ashes of corn-starch and farina are chiefly composed of alkalies, and give little or no reaction for carbonic acid.

"That all the ashes contain iron. The ash of Corn-Starch No. 1 also gave a distinct reaction for manganese.

"Finally, as different specimens of the same article of food may differ in constitution on account of variety in the soil or in the mode of preparation (which latter was probably the cause of the marked difference between the two specimens of corn-starch), these determinations cannot be taken as giving an absolute standard of nutritive value, but only as affording a probable index of results and a means of comparison of the nutritive powers of each."

Professor Horsford also exhibited specimens of the metal Aluminum, to show its malleability, silver lustre, and other physical properties. It was first obtained by Sir Humphrey Davy, and has recently been prepared by Wöhler's method on a more extended scale by Deville of Paris. It is obtained from common alum most conveniently, from 100 parts of which about 5.78 parts of aluminum can be obtained by a very expensive process; it is made by decomposing the chloride of aluminum by potassium or sodium. Its weight is 2.56.

Professor Gray presented the following paper, entitled, "Characters of New Genera of Plants, mostly from Polynesia, in the Collection of the United States Exploring Expedition, under Captain Wilkes (continued)."

"ACICALYPTUS, Nov. Gen. Myrtacearum.

"Calyx subulæformis, acute tetragonus, clausus; apice subulato-rostrato operculiformi sub anthesi circumscisse deciduo; fauce ultra ovarium longe producta. Petala 4, in operculum leviter cohærentia, sub anthesi dejecta. Stamina plurima, discreta, margini calycis tubi inserta: filamenta filiformia; antheræ biloculares, loculis ovalibus. Stylus filiformis: stigma obtusum. Ovarium biloculare, dissepimento tenui. Ovula in loculis 8–10, anatropa, subcurvata? (Fructus ignotus, forte carnosus indehiscens.) — Arbor vel arbuscula; foliis oppositis ovatis penninerviis impunctatis; floribus cymosis terminalibus.

"ACICALYPTUS MYRTOIDES. — Feejee Islands.

" SPIRÆANTHEMUM, Nov. Gen. Saxifragacearum.

"Flores polygamo-dioici, vel hermaphroditi. Calyx quadri-quinquefidus, æstivatione valvatus, persistens. Corolla nulla. Stamina 8 vel 10, imæ basi calycis inserta, fere hypogyna: filamenta filiformia, fl. masc. exserta, hermaphrodito-fert. calyce haud longiora: antheræ didymæ, biloculares, longitudinaliter dehiscentes. Squamulæ disci hypogynæ fl. masc. 4 vel 5, subcoalitæ, apice dentatæ; fl. fert. 8 vel 10, staminibus alternæ, sæpe emarginatæ. Ovaria maris nulla; fœm. 4 vel 5, discreta, libera, calycis lobis alterna, ovoideo-fusiformia, in stylos breves attenuata; stigmata terminalia subcapitata. Ovula gemina collateralia, vel solitaria, pendula, subanatropa. Folliculi 4–5, compressi, cartilaginei vel coriacei, intus longitudinaliter dehiscentes, mono–dispermi. Semina oblonga, compressa; testa membranacea aut superne aut utrinque alato-producta. Embryo subcylindricus, albumine carnoso parum brevior; cotyledonibus oblongis planiusculis radicula supera dimidio brevioribus. — Frutices vel arbusculæ Polynesicæ; foliis oppositis seu verticillatis simplicibus; stipulis interpetiolaribus deciduis; floribus parvis paniculatis; pedicellis articulatis.

" 1. SPIRÆANTHEMUM SAMOENSE (sp. nov.): ramis pubescentibus; foliis oppositis ovalibus subacuminatis basi rotundatis serratis insigniter penninerviis; paniculis folia excedentibus; folliculis dispermis; seminibus utrinque appendiculatis. — Samoan or Navigators' Islands.

"2. SPIRÆANTHEMUM VITIENSE (sp. nov.): glabrum; foliis oppositis et verticillatis obovato-ellipticis oblongisve obtusis basi attenuatis integerrimis paucivenosis paniculas excedentibus; folliculis monospermis; semine superne alato. — Feejee Islands.

" REYNOLDSIA, Nov. Gen. Araliacearum.

" Flores polygami. Calyx basi nudus; tubo cum ovario connato; limbo brevissimo integerrimo vel subrepando. Petala 8 – 10, epigyna, valvata, apice in calyptræ formam coalita, sub anthesi dejecta. Stamina 8 – 10, cum petalis inserta, iisdem alterna: filamenta brevia: antheræ lineares. Ovarium inferum, 8 – 17 loculare: stylus nullus vel subnullus: stigma indivisum, 8 – 18-radiatum. Ovula in loculis solitaria, suspensa, anatropa. Drupa baccata, globosa, 8 – 18-pyrena; pyrenis cartilagineis. Embryo in apice albuminis dense carnosi minutus; radicula supera cylindrica. — Arbores insularum Pacifici, glabræ, inermes, exstipulatæ; foliis simpliciter pinnatis sæpissime trijugis cum impari, foliolis subdentatis; umbellis racemisve compositis paniculatis laxifloris.

"1. REYNOLDSIA SANDWICENSIS (sp. nov.): foliolis subcordatis; corolla clausa oblonga: stigmate 8 – 10-radiato; drupa 8 – 10-pyrena. — Sandwich Islands.

"2. REYNOLDSIA PLEIOSPERMA (sp. nov.): foliolis ovatis seu lanceolato-oblongis; corolla clausa conica vel ovoidea; stigmate 15 – 18-radiato; drupa 15 – 18-pyrena. — Samoan Islands.

"TETRAPLASANDRA, Nov. Gen. Araliacearum.

"Flores polygami? Calyx tubo hemisphærico cum ovario connato; limbo brevissimo truncato vix denticulato. Petala 7 – 8, epigyna, valvata, leviter calyptratim cohærentia, caduca. Stamina cum petalis inserta, iisdem numero quadrupla, nempe 28 v. 32, uniseriata: filamenta brevia: antheræ oblongæ, subsagittatæ. Ovarium 7 – 10-loculare: stylus nullus: stigma indivisum, obsolete 7 – 10-radiatum, stylopodio brevi conico impositum. Ovula in loculis solitaria, suspensa, anatropa. Drupa baccata, 8 – 10-pyrena; pyrenis coriaceis. (Embryo haud visus.) — Arbor procera, inermis; foliis exstipulatis pinnatis 5 – 7-foliolatis subtus incanis; umbellis decompositis paniculatis.

"TETRAPLASANDRA HAWAIENSIS. — Hawaii, Sandwich Islands.

"PLERANDRA, Nov. Gen. Araliacearum.

"Flores polygamo-monoici vel dioici? *Masc.* Calyx tubo turbinato cum ovario connato; limbo brevissimo post anthesin repando-undulato. Petala 4? epigyna, oblonga, æstivatione valvata, mox decidua. Stamina indefinita, epigyna, pluriserialia: filamenta filiformia: antheræ oblongæ. Ovarium 14 – 15-loculare; ovula in loculiis solitaria, parva, suspensa, sæpius abortiva vel nulla. Stigma truncatum, obsolete multiradiatum, stylopodio conico impositum. *Fœm.* ignoti. — Arbor 20-pedalis, macrophylla; foliis digitatis 9-foliolatis; umbellis compositis.

"PLERANDRA PICKERINGII. — Feejee Islands."

Four hundredth meeting.

May 9, 1854. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. Kneeland exhibited to the Academy a large piece of the bark of the *Wellingtonia gigantea*, and a lithograph of one of these immense trees executed in San Francisco.

Professor Gray remarked that the bark resembled that of the Southern Cypress, being, however, less fibrous and stringy. He suspected that there would be found on this tree two kinds of leaves, as in the Deciduous Cypress; and was still inclined to suppose that it is not generically distinct from *Sequoia*, although the question can hardly be settled until the male flowers are known. These specimens gave rise to an interesting discussion on the age of this tree, and on the size and age of large trees generally.

"*Voted*, That the meeting of the fourth Tuesday of May be omitted, on account of the proximity of the Annual Meeting."

Four hundred and first meeting.

May 30, 1854. — ANNUAL MEETING.

The VICE-PRESIDENT in the chair, in the absence of the President.

Professor Lovering, from the Committee of Publication, and Dr. Shurtleff, from the Library Committee, made verbal reports of the operations of these committees. Dr. Shurtleff announced that a complete card-catalogue of the Library had been prepared.

The report of the Treasurer was read, and his statement of accounts was ordered to be entered on the records.

The chair reported, from the committee raised to consider the subject of lectures for the present year, that the committee deemed it inexpedient to arrange for a course of lectures for the ensuing winter; and the committee was discharged.

The chair announced that the Academy had sustained the loss of the following members by death during the last two years, viz.: —

Of Fellows.

Samuel Putnam,	John Davis,
Andrews Norton,	A. L. Pierson,
J. E. Teschemacher,	J. Tilden,
John Farrar,	G. C. Shattuck.

Of Associate Fellows.

E. H. Courteney,	Daniel Webster,
Sears C. Walker,	Horatio Greenough.
Isaac Bates,	

Of Foreign Honorary Members.

Leopold von Buch,	Fischer de Waldheim,
Adrien de Jussieu,	M. Arago.

"The Academy has already, in many instances, recorded its appreciation of the character and services of these distinguished associates. No eulogy upon them, therefore, is now required of us. We cannot, however, read over these names (in all seventeen) collectively, without reflecting upon the great amount of varied learning and of intellectual and moral power represented by them. Nor can we remain without some shade of anxiety, when we look to the community about us, to find those worthy to become their successors."

Sir William Hamilton, Professor of Logic in the University of Edinburgh, was elected a Foreign Honorary Member in Class III. Section 1.

Professor C. Th. von Siebold of Breslau was elected a Foreign Honorary Member in Class II. Section 3.

Dr. B. A. Gould mentioned, "that his attention had been directed to a paragraph on page 48 of the current volume of Proceedings, in which some remarks by him at the meeting of September 28, 1853, had been singularly misapplied in the record. Had he been present when the records were read, or at home when they were printed, such a statement could not have occurred. To astronomers no disavowal would be needed; still he desired, for the credit of the Academy at least, to place the fact of such misreport on its record. His communication, which was an oral one, referred to the use of certain formulas of reduction; and different portions of a conversational discussion had been confused by the Secretary in such a manner as to occasion the extraordinary statement given in the record."

The election of officers was held in the usual form, and the following were chosen: —

JACOB BIGELOW, ...	*President.*
DANIEL TREADWELL, . .	*Vice-President.*
ASA GRAY, ...	*Corresponding Secretary.*
SAMUEL L. ABBOT, . . .	*Recording Secretary.*
EDWARD WIGGLESWORTH, .	*Treasurer.*
NATHANIEL B. SHURTLEFF,	*Librarian.*

The following gentlemen were chosen Members of the Council for Nomination, viz.: —

JOSEPH LOVERING,	of Class I.
J. I. BOWDITCH,	
BENJAMIN A. GOULD, JR.	
GEORGE B. EMERSON,	of Class II.
LOUIS AGASSIZ,	
JOHN B. S. JACKSON,	
JAMES WALKER,	of Class III.
JARED SPARKS,	
NATHAN APPLETON,	

The several Standing Committees were appointed on nomination from the chair, as follows: —

Rumford Committee.

EBEN N. HORSFORD,
DANIEL TREADWELL,
JOSEPH LOVERING,
HENRY L. EUSTIS,
MORRILL WYMAN.

Committee of Publication.

JOSEPH LOVERING, LOUIS AGASSIZ, FRANCIS BOWEN.

Committee on the Library.

Augustus A. Gould, Benjamin A. Gould, Jr.,
J. P. Cooke, Jr.

"*Voted*, That a meeting for scientific communications he held on the last Tuesday of June, at half past seven o'clock, P. M."

DONATIONS TO THE LIBRARY,

FROM DECEMBER, 1851, TO OCTOBER, 1854.

Amasa Walker, Esq.

Transactions of the Agricultural Societies in the State of Massachusetts for 1851. 1 vol. 8vo. Boston.

Charles Brooks.

The Tornado of 1851 in Medford, &c. 1 vol. 24mo. Boston. 1852.

James P. Espy.

Reports on Meteorology. Long 4to. Washington. 1849-51. 1 vol.

American Philosophical Society.

Proceedings, Vol. V., Vol. VI. No. 51. January to June, 1854. 8vo.

Transactions. New Series. Vol. X. Parts II. and III. 4to. Philadelphia.

B. A. Gould, Jr., P. D.

Astronomical Journal. Nos. 29 to 75. 4to. Cambridge. 1851, to September 19, 1854.

Massachusetts Historical Society.

Collections. 4th Series. Vol. I.

American Oriental Society.

Journal. Vol. III., 1853. Vol. IV., 1854. 8vo. New York and London.

Proceedings at the Semiannual Meeting of the American Oriental Society, held in New Haven, October 13 and 14, 1852. Proceedings at the Annual Meeting held in Boston, May 18 and 19, 1853. 8vo pamph.

Netherlands Government.

Flora Batava. Aflev. 165-174. 4to. Amsterdam.

British Government.

Observations made at the Magnetical and Meteorological Observatory at Hobarton, in Van Diemen Island. Printed by Government, under the Superintendence of Colonel Edward Sabine. Vol. II. from 1843 to 1850, inclusive. 1 vol. 4to. London. 1852.

Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada, under the Superintendence of Colonel Edward Sabine. Vol. II. 1843, 1844, 1845. With Abstracts of the Observations to 1848, and in some Cases to 1852, inclusive. 1 vol. 4to. London. 1853.

Report on the Geology of Cornwall, Devon, and West Somerset, by Henry T. de la Beche, F. R. S., &c., Director of the Ordnance Geological Survey. Published by Order of the Lord's Commissioners of Her Majesty's Treasury. 1 vol. 8vo. London. 1839.

Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, observed in the Course of the Ordnance Geological Survey of that District. By John Phillips, F. R. S., &c. Published by Order of the Lords Commissioners of Her Majesty's Treasury. 1 vol. 8vo. London. 1841.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Economic Geology in London. Published by Order of the Lords Commissioners of Her Majesty's Treasury. Vol. I. 8vo. London. 1846. Vol. II. Parts I. and II. 1848.

Memoirs of the Geological Survey of the United Kingdom. Figures and Descriptions illustrative of British Organic Remains. Decades 1, 2, 3, 4, and 6. 1849 – 52. 4to. London. 5 pamph.

Museum of Practical Geology and Geological Survey. Records of the School of Mines and of Science applied to the Arts. Vol. I. Part. I. Inaugural and Introductory Lectures to the Courses for the Session 1851 – 52. Published by Order of the Lords Commissioners of Her Majesty's Treasury. 1 vol. 8vo. London. 1852.

Museum of Practical Geological Government School of Mines, and of Science applied to the Arts, and Industrial Instruction on the Continent (being the Introductory Lecture of the Session). By Lyon Playfair, C. B., F. R. S. 8vo pamph. London. 1852.

Boston Society of Natural History.

Proceedings. Vol. IV. 1851 – 54. 8vo. Boston.

Journal. Vol. VI. No. 3. 8vo. Boston. 1853.

Address to the Boston Society of Natural History, by John C. Warren, President of the Society. 8vo pamph. Boston. 1853.

Catalogues of the Animals and Plants of Massachusetts, with a copious Index. 8vo pamph. Amherst. 1835.

Academy of Natural Sciences of Philadelphia.

Proceedings, Vol. VI., Vol. VII. Nos. 1, 2, and 3. 8vo. Philadelphia.

Journal. New Series. Vol. II. Parts III. and IV. 4to. Philadelphia.

American Journal of Science and Arts.

Second Series. Vols. XIV. – XVII. and Vol. XVIII. Nos. 52, 53. 8vo. New Haven. From the Editors.

New York University.

Sixty-fifth, Sixty-sixth, and Sixty-seventh Annual Reports of the Regents of the University of the State of New York. 8vo. 3 vols. Albany. 1852 – 54.

Fifth and Sixth Annual Reports of the Regents of the University, on the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collection annexed thereto. 8vo. Albany. 1852 and 1853.

Catalogue of the Cabinet of Natural History of the State of New York. 8vo. Albany. 1853.

E. B. O'Callaghan.

The Documentary History of the State of New York, arranged under the Direction of the Hon. Christopher Morgan, Secretary of State. Vol. IV. Albany. 1851. 8vo.

Acadèmie Impériale des Sciences de Saint Petersbourg.

Mémoires. VI^me^ Serie. Sciences Mathematiques, Physiques, et Naturelles. Tome Septième. Seconde Partie : Sciences Naturelles. Tome Cinquième, 5^me^ et 6^me^ Livraisons. 1 pamph.

Mémoires, Sciences Mathematiques, Physiques, et Naturelles. Tome Huitième. Seconde Partie : Sciences Naturelles. Tome Sixième, 4^me^ Livraison. 1849. 1 pamph.

Mémoires. Première Partie : Sciences Mathematiques et Physiques. Tome Cinquième, 3^me^ et 4^me^ Livraisons. 1849 et 1850. 2 pamph.

Mémoires des Savants Etrangers. Tome VI. 4^me^ Livraison. 1 pamph. St. Petersbourg. 1849.

Recueil des Actes de l'Académie 1847 et 1848. 1 pamph. 4to. St. Petersbourg. 1849.

Catalogue des Manuscrits et Xylographes Orientaux de la Bibliothèque Impériale Publique de St. Petersbourg. 8vo. St. Petersbourg. 1852.

Mémoires présentées à l'Académie Impériale des Sciences de St. Petersbourg par divers Savants et lus dans ses Assemblées. Tome Sixième, 2 et 3 Livraisons. 4to. St. Petersbourg. 1848 et 1849. 2 pamph.

Mémoires de l'Académie Imp. des Sc. de St. Petersbourg, VI^{me} Serie. Sciences, Math., Phys., et Natur. Tome Huitième. Seconde Partie: Sciences, Natur. Tome Sixième, 3, 5, et 6 Livraisons. 4to. St. Petersbourg. 1849. 2 pamph.

Imperial Mineralogical Society, St. Petersbourg.

Verhandlungen der Russ. Kaiserl. Mineral. Gesell. zu St. Petersbourg. 1842–49. 6 vols. 8vo. 1842–50. St. Petersbourg. (Vols. for 1845–47, duplicates.)

Schriften der in St. Petersburg, gestifelen Russ. Kais. Gesell. für die gesammte Mineralogie. Band I. Abth. 1 und 2. 2 vols. 8vo. St. Petersbourg. (Duplicate.)

Administration of Mines of Russia.

Annales de l'Observatoire Physique Central de Russie, 1850. Parts I. and II. 2 vols. 4to. St. Petersbourg. 1853.

Compte-Rendu Annuel, 1852. (Supplement to the Annals.) 4to. St. Petersbourg. 1853.

C. Lehman.

Novarum et minus cognitarum Stirpium pugillus nonus, addita nova Recensione nec non Enumeratione Specierum omnium Generis Potentillarum, earumque Synonimia locupletissima. 4to pamph. Hamburg. 1851.

Lyceum of Natural History of New York.

Annals. Vol. V., Vol. VI. Nos. 1–4. 1854. 8vo. New York.

Joseph Leidy.

On the Osteology of the Head of Hippopotamus, and a Description of the Osteological Characters of a new Genus of Hippopotamidæ. 4to pamph. Philadelphia.

Smithsonian Institution.

Smithsonian Contributions to Knowledge. Vols. III. and IV. 4to. Washington. 1852. Vol. V. 4to. Washington. 1853.

Smithsonian Report on Recent Improvements in the Chemical Arts, by Professor James C. Booth and Campbell Monfit. Washington. 1852. Pamph.

Sixth Annual Report of the Board of Regents of the Smithsonian Institution, &c. Washington. 1852. Pamph.

Smithsonian Contributions to Knowledge. Memoir of the Extinct Species of American Ox. By J. Leidy, M. D. Washington. 1852. Pamph.

The Annular Eclipse of May 26, 1854. Published under the Authority of Hon. James C. Dobbin, Secretary of the Navy, by the Smithsonian Institution and Nautical Almanac. 8vo pamph. Washington. 1854.

Edward Everett.

Extracts from the Letter-Press of the Astronomical Observations made at the Royal Observatory, Edinburgh, by the late Thomas Henderson. Vol. X. for 1844 – 47. 4to pamph. Edinburgh.

John C. Warren, M. D.

Description of a Skeleton of the Mastodon giganteus of North America. 4to pamph. Boston.

Royal Society of London.

Proceedings. 12 numbers to complete Vols. III. and V. 1830 – 50. Vol. VI. pp. 1 to 336, from December, 1850, to November 17, 1853. 8vo. London.

Philosophical Transactions for 1852 (Parts I. and II.), 1853 (Parts I. and II.). Vol. CXLIII. 4to. London.

Fellows of the Royal Society, November 30, 1852. 4to pamph.

Catalogue of Stars near the Ecliptic, observed at Markree during the Years 1848 – 50, and whose Places are supposed to be hitherto unpublished. Vol. I. containing 14,888 Stars. — Catalogue, &c. during the Years 1851 and 1852. Vol. II. containing 15,289 Stars. 2 vols. 8vo. Dublin. 1851 and 1853.

Astronomical, Magnetical, and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1851. 1 vol. 4to. London. 1853.

Address of the Right Honorable the Earl Rosse, President, read at the Anniversary Meeting of the Royal Society, Tuesday, November 30, 1852. 8vo. London. 1853.

Astronomical Observations made by the Rev. Thomas Catton, B. D. Reduced and printed under the Superintendence of George Biddel Airy, Esq. 4to pamph. London. 1853.

Emmanuel Liais.

Mémoire sur la Substitution des Electromoteurs aux Machines à

Vapeur, et Description d'une Horloge Magneto-electrique. 8vo pamph. Paris. 1852.

Note sur les Observations faites à Cherbourg, pendant l'Eclipse du 28 Juillet, 1851. 8vo. Cherbourg. 1851.

Addition à un Mémoire, sur les Oscillations du Baromètre. 8vo. Cherbourg.

Professor C. B. Adams.

Catalogue of Shells collected at Panama, with Notes on their Synonymy, Station, and Geographical Distribution. 4to. New York. 1852.

Contributions to Conchology. No. II. Hints on the Geographical Distribution of Animals, with special Reference to the Mollusca. October, 1852.

Society of Sciences, Harlem.

Extrait du Programme de la Société Hollandaise des Sciences à Haarlem, pour l'Année 1852.

Historische en Letterkundige Verhandelingen van de Hollandsche Maatschappij der Wettenschappen te Haarlem. Erste Deel. 4to. Haarlem. 1851.

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wettenschappen te Haarlem. 8 und 9 Deel. 4to. Haarlem. 1853 und 1854.

American Association for the Advancement of Science.

Proceedings. Sixth Meeting, held at Albany, N. Y., August, 1851. Published by the Liberality of the Citizens of Albany. 8vo. Washington. 1852.

Howard Stansbury, U. S. A.

Exploration and Survey of the Valley of the Great Salt Lake of Utah, including a Reconnoissance of a new Route through the Rocky Mountains. Printed by Order of the Senate of the United States. 8vo. Philadelphia. 1852. 2 vols. Plates.

A. A. Gould.

The History of New Ipswich, from its first Grant in 1736 to the present Time, with Genealogical Notices of the Principal Families, and also the Proceedings of the Centennial Celebration, September 11, 1850. By Dr. A. A. Gould. Boston. 8vo. 1 vol.

Sir Roderick Impey Murchison, F. R. S.

On the Meaning of the Term "Silurian System" as adopted by Geologists in various Countries during the last Ten Years. From the Quarterly Journal of the Geological Society of London for August, 1852. Vol. VIII. 8vo. London. 1852.

Jacob Bigelow, M. D.

Address to the Royal Geographical Society of London. Delivered at the Anniversary Meeting, May 24, 1852. By Sir R. I. Murchison. 8vo. London. 1852.

British Association for the Advancement of Science.

Report of the Twenty-first Meeting, held at Ipswich, July, 1851. — Report of the Twenty-second Meeting, held at Belfast, September, 1852. 2 vols. 8vo. London. 1852 and 1853.

Académie des Sciences de l'Institut de France.

Mémoires. Tome XXIII. 1853.

Mémoires Présentés. Tome XIII. 1852.

Comptes Rendus. Tomes XXXII. – XXXVIII. 1851 – 54. Tome XXXIX. Nos. 1 – 7. 1854.

Imperial Academy of Sciences, Vienna.

Sitzungsberichte.

Math.-Natur. Classe. Bande VII. – IX. 1851 und 1852. 8vo. Wien. Band X. Heft 1, 4, 5. Band XI. Heft 1 – 4, bis November 4, 1853. 8vo pamph.

Phil.-Hist. Classe. Bande VII. – IX. 1851 und 1852. 8vo. Wien. Band X. Heft 1, 4, 5. Band XI. Heft 1 – 3, bis October, 1853. 8vo pamph.

Almanach der K. Akad. der Wiss. zu Wien. 1 vol. 12mo.

Die feierliche Sitzung der K. Akad. der Wiss. am 29 Mai, 1852. 8vo. Wien.

Verzeichniss der im Buchbandel befindlichen Druckschriften der K. Akad. der Wiss. zu Wien. 8vo. 1852.

Almanach der K. Akad. der Wiss. 12mo. Wien. 4ter Zahrgang. 1854.

Royal Society of Sciences, Göttingen.

Erste Sacularfeier der König. Gesell. der Wiss. zu Göttingen, am 29 November, 1851. 4to. 1852.

Nachrichten. 1851, Nr. 1 bis 19. 1852, Nr. 1 bis 14. 12mo. Göttingen.

Abhandlungen der K. Gesell. der Wiss. zu Göttingen. 5 Band. 1851 und '52. 4to. Göttingen. 1853.

Royal Prussian Academy.

Abhandlungen der Königl. Akad. der Wiss. zu Berlin. 1850 – 52. 4to. 3 vols. Berlin. 1851 – 53.

Monatsbericht. Ausdem Jahre 1851 und 1852. 2 vols. 8vo. 1853, Januar – Juli. 7 Nos. 8vo.

Dr. J. G. Flugel.

Kritische Durchsicht der Von Dawidow verfassten Wörtersammlung aus der Sprache der Ainos. Von Dr. Aug. Pfizmaier. Wien. 8vo. 1851.

Kalender der Flora des Horizontes von Prag. entworfen nach zehnjahrigen Vegetations-Beobachtungen von Karl Fritsch. 8vo. 1852.

Tafeln zur Reduction der in millimetern abgelesenen Barometerstande auf die Normaltemperatur von 0° Celsius, Berechnit von J. J. Pohl und J. Schabus. 8vo pamph. Wien. 1852.

Tafeln zur Vergleichung und Reduction der in Längenmassen abgelesenen Barometerstande. 8vo pamph. Wien. 1852.

L. Lea, Esq., and G. W. Manypenny.

Historical and Statistical Information respecting the History, Condition, and Prospects of the Indian Tribes of the United States. Collected and prepared under the Direction of the Bureau of Indian Affairs, by Act of Congress of March 3, 1847. By Henry R. Schoolcraft, LL. D. Illustrated by S. Eastman, Captain in the United States Army. Parts II. and III. 4to. Philadelphia. 1852 and 1853.

Charles T. Jackson, M. D.

Congressional Report of Hon. Edward Stanley of North Carolina and Hon. Alexander Evans of Maryland, on the Ether Discovery. Thirty-second Congress, First Session, 1852. Printed by Authority of the Minority of the Committee.

Academia Naturæ Curiosorum.

Verhandlungen der Kaisersl. Leopold. Carol. Akad. der Naturforscher. Band XXIII. Pars II. 1852. Band XXII. Supplement. 1852. Band XXIV. Pars I. 1854. 4to. Breslau und Bonn.

Vorwort zum Vierundzwanzigsten Bande der Verhandlungen der K. L. C. Akad. Besondere Ausgabe. 4to. Breslau und Bonn. 1853.

Royal Danish Academy.

Oversight over det Kgl. Danske Videnskabernes Selskabs Forhandlingen. 1849 – 51. 8vo. 3 vols. Kjobenhavn.

Skrifter 5^{e} Rœkke. Natur. og Math. Afdeling. 2^{e} und 3^{e} Bind. 4to. 1851 – 53. Kjobenhavn.

Skrifter 5^{e} Rœkke. Histor. og Philos. Afdeling. 1^{e} Bind. 4to. 1852.

Tables du Soleil, exécutées d'apres les Ordres de la Soc. Roy. des Sciences de Copenhague par MM. P. A. Hansen et C. F. R. Olufsen. 4to. Copenhague. 1853.

Professor Hausman.

Die Mineral Regionen der obern halbinsel Michigan's (N. A.) am Lake Superior und die Isle Royal. Von C. L. Koch. 8vo. Göttingen. 1852.

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Magnetische und Geographische Ortsbestimmungen im Oesterreichischen Kaiserstaate. 1851. 4to pamph. Prag. 1852.

Paleontographical Society.

Report of the Council to a General Meeting held March 24, 1851. 8vo pamph.

J. S. Bowerbank, Esq.

On a Siliceous Zoöphyte, Alcyonites Parasiticum. From the Quarterly Journal of the Geological Society of London for November, 1849. Pamph.

On the Pterodactylas of the Chalk Formation. From the Proceedings of the Zoölogical Society of London, January 14, 1851. 8vo.

Microscopical Observations on the Structure of the Bones of Pterodactylus Giganteus and other Fossil Animals. From the Quarterly Journal of the Geological Society of London for February, 1848. 8vo.

On the Siliceous Bodies of the Chalk and other Formations, in Reply to Mr. J. Toulmin Smith. From the Annual and Magazine of Natural History for 1847. 8vo pamph. London. 1847.

F. G. W. Struve.

Mersungen zur bestimmung des höhenunterschiedes zwischen dem Schwartzen und Caspichen Meere. Von G. Tuss, Sawitch, und Sabler. 1836 und 1837. 1 vol. 4to. St. Petersb. 1849.

Beobachtung der totalen Sonnenfinsterniss am 28 (16) Juli, 1851, in Lomsæ. Von Otto Struve. 8vo pamph. St. Petersb. 1851.

Résultats des Operations géodésiques de M. M. G. Fuss, Sawitch, et Sabler, exécutées en 1836 et 1837, dans la Province la Caucasienne. 4to pamph. St. Petersb. 1849.

Stellarum Fixarum imprimis duplicium et multiplicium Positiones

Mediæ pro Epocha 1830.0, deductæ ex Observationibus Meridianis Annis 1822 ad 1843 in Specula Dorpatensi Institutis. Folio. Petropoli. 1852.

Sur les Dimensions des Anneaux de Saturne. Par M. Otto Struve. 4to pamph. St. Petersb. 1852.

Exposé Historique des Travaux exécutés jusqu'à la Fin de l'Année 1851 pour la Mesure de l'Arc du Méridien entre Fuglenäes 70° 40′ et Ismail 45° 20′. Suivi de deux Rapports de M. G. Lindhagen sur l'Expédition de Finnmarken en 1850 et sur les Opérations de Lapponie exécuteés en 1851. 4to pamph. St. Petersb. 1852.

Walter Channing, M. D.

Professional Reminiscences of Foreign Travel. 8vo. Boston.

L. A. Huguet Latour.

A Retrospective Glance at the Progressive State of the Natural History Society of Montreal. By Major R. Lachlan. 8vo pamph. Montreal. 1852.

Journal d'Agriculture et Transactions de la Société d'Agriculture du Bas Canada. Vol. V. Nos. 9 – 12. Vol. VI. Nos. 1 – 4. 8vo. Montreal.

The Mayor of Boston.

A Memorial of Daniel Webster, from the City of Boston. 8vo. Boston. 1853.

Museum d'Histoire Naturelle de Paris.

Archives. Tome V. Liv. 4 — Tome VI. Liv. 1 – 4. 4to. Paris.

Catalogue Méthodique de la Collection des Reptiles. Deuxième Livr. Paris, 1851. Catalogue Méthod. de la Coll. des Mammifères de la Coll. des Oiseaux et des Collections annexées. 2 pamph. Paris. 1851. (Through A. Vattemare.)

Hon. Robert C. Winthrop.

Map of the United States, and their Territories between the Mississippi and the Pacific Ocean, and a Part of Mexico. (Compiled by Order of Congress.)

A. August Duméril.

De la Texture Intime des Glandes, etc. 8vo. Paris. 1844.

Note sur une nouvelle Espèce de Reptile de la Famille des Geckotiens, et appartenant au Genre Stenodactyle. 8vo. 1851.

Des Odeurs, de leur Nature et de leur Action Physiologique. 4to. Paris. 1843.

Dr. A. A. Duméril, et Dr. Demarquay.

Recherches experimentales sur les Modifications imprimées à la Température Animale par l'Ether et par la Chloroforme et sur le Mode d'Action de ces deux Agents. 8vo. Paris. 1848.

Drs. A. A. Duméril, Demarquay, et Lecomte.

Considerations Physiologiques sur les Modifications que subit la Température Animale sous l'Influence de l'Introduction, dans l'Economie de différents Agents. 8vo. Paris. 1852.

Annuaire de Thérapeutique et de Matière Médicale. (Through Dr. D. H. Storer.)

George C. Rand.

Sermon after the Interment of Hon. Daniel Webster. By Nehemiah Adams, D. D.

Charles Cramer.

Brief Astronomical Tables, on a simple Plan for the Expeditious Calculation of Eclipses in all Ages. By W. Drew Snooke.

Thomas J. Sumner, Esq., of S. C.

Analysis of the Cotton Seed and Plant. 8vo pamph. Philadelphia. 1852.

Charles M. Wetherill, Ph. D.

Chemical Examination of two Minerals from the Neighborhood of Reading, Pa., and on the Occurrence of Gold in Pennsylvania. 4to. Philadelphia.

On a new Variety of Asphalt (Melan-Asphalt). 4to. Philadelphia. 1852.

On the Neutral Sulphate of the Oxyde of Ethyle, and the Products of its Decomposition by Water. 4to. Philadelphia. 1848.

On a new Apparatus for the Determination of Carbonic Acid, and on Kemp's Thermostat. 8vo. Philadelphia.

W. T. G. Morton.

Statements supported by Evidence of Wm. T. G. Morton, M. D., on his Claim to the Discovery of Anæsthetic Properties of Ether, submitted to the Honorable the Select Committee appointed by the Senate of the United States, Thirty-second Congress, Second Session, January 21, 1853. Washington. 1853. 1 vol.

Royal Netherlands Institute.

Verhandelingen der Eerste Klasse van het Koninklijk-Nederlandshe Institut van Wetenschappen, &c. te Amsterdam. 3° Reeks, 5° Deel. 4to. Amsterdam. 1851 und 1852.

Jaarboek. Voor 1851. 8vo. Amsterdam.

Tijdschrift voor de Wis-en Natuurkundige Wetenschappen. 5° Deel. 1°, 2°, 3° of laatste Aflever. 8vo. Amsterdam. 1851 – 52.

Linnæan Society of London.

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Beobachtungen des Meteorologischen Observatoriums auf dem Hohenpeissenberg von 1792–1850. Von Dr. J. Lamont. 8vo pamph. München. 1851.

Dr. Carl Prankl.

Die gegenwärtize Aufgabe der Philosophie. 4to pamph. München. 1852.

Architektonische Zeichnunger als Beilage zu den zwei Abhandlungen über das Erechtheum von Edw. Mezger. 4to pamph. München. 1852.

Annalen der Königlischen Sternwarte bei München. Von Dr. J. Lamont. Vol. V. Mit Astronomischen Kalender für 1853. 8vo pamph. München. 1852.

Ueber den Chemismus der Vegetation. Von Dr. A. Vogel, Jr. 4to pamph. München. 1852.

Afrika vor den Entdeckungen der Portugiesen. Von Dr. Friedrich Kunstman. 4to pamph. München. 1853.

Dr. C. Fr. Phr. Martius.

Wegweiser für die Besucher des K. Botanischen Gartens in München, nebst einem Verzeichnisse der in demselben vorhandenen Pflanzengattungen. 12mo pamph. München. 1852.

J. G. Krabinger.

Die Classischen Studien und ihre Begner. 8vo pamph. München. 1853.

Dr. Fr. P. W. Herman.

Ueber die Bewegung der Bevolterung im Königreiche Bayern. 8vo pamph. München. 1853.

Friedrick Thiersch.

Rede zur Borfeyer des hohen Geburtsfestes. 4to pamph. München. 1853.

Deming Jarves.

Reminiscences of Glass-Making. 8vo pamph. Boston. 1854.

Four hundred and second meeting.

June 27, 1854. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor J. S. Cooke presented a memoir "On Stibiobizincyle and Stibiotrizincyle, two new Compounds of Zinc and Antimony." This memoir was referred to the Committee of Publication.

Four hundred and third meeting.

August 9, 1854. — QUARTERLY MEETING.

The PRESIDENT in the chair.

At the request of the Treasurer, the following vote was laid before the Academy, and unanimously adopted: —

> " *Voted*, That the Secretary be directed to inform the executors of our late esteemed associate, Dr. George C. Shattuck, that the Academy have received his bequest, a share in the Cocheco Manufacturing Company, and to express their grateful sense of this mark of his regard."

A paper was received from Professor Gray, entitled, "Characters of some New Genera and Species of Plants in a Collection made by George Thurber, Esq., of the late Mexican Boundary Commission, chiefly in New Mexico, Southwest California, and Sonora." The plants described are *Ranunculus hydrocharoides; Argemone fruticosa*, Thurber; *Malvastrum Thurberi; Abutilon Thurberi; Thurberia thespesioides*, a new and striking Malvaceous genus allied to Thespesia; *Holacantha Emoryi*, a new genus of Simarubaceæ allied to Castela; *Guaiacum Coulteri; Astragalus Thurberi; Daubentonia Thurberi; Robinia Neo-Mexicana;* five new species of *Dalea; Hosackia argophylla; Acacia? crassifolia*, an anomalous species as to the foliage; *Potentilla Thurberi*, a new red-flowered species; *Petalonyx Thurberi*, an interesting addition to the tribe Gronovieæ of the order Loasaceæ; *Eremiastrum bellioides*, an Asteroid genus, intermediate between Erigeron and Bellium; *Melampodium longicorne; Dy-*

sodia porophylloides; Psathyrotes incisa; Bartlettia scaposa, a new genus of Senecioneæ, dedicated to the U. S. Boundary Commissioner under whose instructions this collection was made; *Perezia Thurberi; Stephanomeria Thurberi; Jacquinia pungens;* and *Pilostyles Thurberi*, a parasitic flower of the order Rafflesiaceæ, of which it is the only representative in North America.

Professor Horsford exhibited an obstruction which had been removed from a wooden pump-log at the Water-Cure establishment of Brattleboro, Vt., formed of a compact mass of small root-fibres, entirely closing the tube of the log. It was three feet in length, and was developed from a slender fibre of the root of a neighboring tree, which had penetrated by a small crevice at a joint in the log. The log had been two years in the ground.

Dr. Walter Channing asked for an explanation of the fact, that, in solar eclipses, the luminous spots upon the ground produced by the light which penetrated the foliage were always of the same shape as the uneclipsed portion of the sun.

Professor Lovering remarked in reply: —

"This phenomenon has been frequently noticed. It excited attention in the progress of the great eclipse of 1806, and is mentioned by Sir J. F. W. Herschel in reference to the eclipse of September 7, 1820. The explanation of it which the rectilinear motion of light offers is simple and sufficient. If the aperture is a physical point, a cone of rays will pass through it, having this point as its apex. The section of this cone by a screen at right angles to its axis will have the same figure as the body from which the light comes, and its diameter will be equal to the diameter of the luminous body multiplied by the distance of the screen from the aperture, and divided by the distance of the luminous body from the same point. Hence, for the same body, it increases as the screen is placed at greater distances. If the luminous body is a physical point, and the aperture not, a pencil of rays will pass through, which is a continuation of the cone of which the luminous point is the apex, and the apertures the base. The section of this pencil at right angles to its axis will have the shape of the aperture, and its size will equal that of the aperture itself multiplied by the distance of the luminous point from the aperture added to the distance of the aperture from the screen, and divided by the distance of the luminous point from the aperture. Hence it is obvious that the size increases more slowly than the distance of the screen from the aperture, and in the case of a distant object, like the sun, almost imperceptibly. When neither the aperture nor the luminous object is a physical point, each strives to imprint its own figure upon the screen, and the resulting shape will resemble that of the aperture or the object according to the size of the two images which each would separately impress, as calculated above. If the size of the aperture is to the size of the luminous object as the distance between the aperture and screen is to the distance between the luminous body and the screen, the separate images which the aperture and the luminous body will form are of the same size, and therefore their shape is equally influential in forming the resulting figure. When the distance of the screen is thirty feet from the aperture, the two images above described are of the same size with solar light if the aperture is between three and four inches. Now when the distance between the screen and the aperture is changed, the size of the image which belongs to the luminous body changes much more than that which belongs to the aperture. Consequently, if the screen on which the images are painted is much farther than thirty feet, the size of the aperture being three or four inches, or if the size of the aperture is diminished, the distance between the screen and the aperture remaining the same, the influence of the sun's form will prevail, and in extreme cases the resulting figure will represent the shape of the sun to the exclusion of all trace of the shape of the aperture. Hence with very small apertures the final image will have no resemblance in shape to the aperture, except when received very near to the aperture. But with nearer bodies, as the flame of a candle, the shape of the aperture continues upon the screen at larger distances, or with the same distance when smaller apertures are employed."

Four hundred and fourth meeting.

September 12, 1854. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Sir William Hamilton, accepting his appointment of Foreign Honorary

Member; and from Dr. Walter Channing, resigning the Fellowship of the Academy.

Dr. Hayes presented a pamphlet, "Reminiscences of Glass-Making," by Deming Jarves, accompanying the donation by some remarks on that art. He stated that at the present time the United States are before all other countries in the manufacture of flint glass, both in the quality and quantity of the article produced.

Dr. Hayes also presented the report of the committee of the Franklin Institute, with one of his own appended, on E. G. Pomeroy's new process of coating iron with copper, and exhibited iron spikes coated by the process described.

Professor Lovering exhibited to the Academy Plateau's new instrument, the *Anorthoscope*, and explained its construction and use.

Professor J. Wyman said, that since the previous meeting, in consequence of the remarks then made on the form of the image produced by the sunlight in passing through apertures of various shapes and sizes, he had examined the pupil of the eye in various animals with reference to the point in question. Professor Wyman described this as it exists, of various shapes; but he found by experimenting with apertures of similar shapes cut in cards, that the image of the sun transmitted through them remained always the same, with the exception of a greater or less penumbra at the circumference.

Dr. C. T. Jackson gave an account of the recent discovery of gold at Bridgewater, Vt., where it is found in a vein of quartz a foot and a half thick, in company with sulphuret of lead, silver and copper pyrites. One ton of reduced lead from this locality yields over six hundred dollars' worth of gold.

Four hundred and fifth meeting.

October 10, 1854. — MONTHLY MEETING.

The CORRESPONDING SECRETARY in the chair.

Professor Agassiz called the attention of the Academy to the recent decease of one of the Fellows, Dr. Waldo I. Burnett, and made the following remarks: —

"I rise to perform a sad duty, which, but for my absence, I would have performed sooner. The American Academy of Arts and Sciences has sustained a severe loss by the death of its associate, Dr. W. I. Burnett, who, after a protracted illness, expired of consumption. Dr. Burnett had hardly yet entered upon the stage of active life when disease began to shake his constitution; but such was his devotion to science, such his zeal and perseverance, that, in a state of health which would have prostrated most men, he was unceasingly active and industrious. The consciousness of the probably short duration of his life, of which he spoke occasionally, and always with the greatest calmness, seems to have been a powerful stimulus for him to leave nothing within his reach undone which might advance the cause of science, and secure for himself an honorable place among its devotees. In this respect his short life has been most exemplary. He not only made his way by himself, but he devoted every moment of his time to the increase of his knowledge, rather than to the improvement of his worldly condition. His efforts were crowned with the fullest success, and the papers he has communicated to the Academy, one of which is already published in its Memoirs, and his other scientific contributions, will ever bear testimony to his industry and skill. He was one of the few among us extensively conversant with the whole range of foreign publications upon the subjects with which he was engaged. In his intercourse with his fellow-laborers in the field of science he was modest, unpretending, and ever willing to aid others. As a friend he was true and open. All these amiable and distinguished qualities make his departure from among us a real loss to all true lovers of science. I therefore move that the Academy pass the following resolutions, as expressive of its sense of his great moral worth and scientific eminence.

"*Resolved*, That the Academy feels deeply the loss of its distinguished associate, Dr. W. I. Burnett, who, by his untiring industry, his great scientific accomplishments, and his amiable personal qualities, stood prominent among the rising generation of scientific men in America.

"*Resolved*, That the Academy will cheerfully undertake to print in its Memoirs whatsoever papers he may have left in a condition fit for publication.

"*Resolved*, That the American Academy tenders to the family of Dr. Burnett its sincere sympathies for their irreparable loss.

"*Resolved*, That a copy of these resolutions be sent to the family of Dr. Burnett, and printed in the public papers."

These resolutions were seconded by Dr. S. L. Abbot, and unanimously adopted.

Professor J. Lovering then rose, and said: —

"May I call the attention of the Academy to another loss it has sustained in the recent and sudden death of Macedoine Melloni, the news of which arrived in this country almost contemporaneously with the report of a new paper which he had presented to the French Academy. In the preface to his great work, *La Thermochrôse*, Melloni confesses the great admiration which he had felt for nature from his youth: 'Mais rien ne frappait autant mon imagination que le lieu si intime qui reunit les phénomènes de la vie à l'astre brillant du jour.' He began to teach *Physics* as soon as he left the school-bench, and continued at that employment for seven years, from 1824 to 1831, when the courses of the University of Parma were discontinued. Here he came into valuable contact with Nobili, whose thermo-multiplier he adopted and perfected with the assistance of the skilful artist of Paris, Ruhmkorff. Political troubles banished Melloni from Italy, but he found an asylum in France, and a kind friend in Arago. He accepted a Professorship in the Department of the Jura, and afterwards went to Geneva for six months. In 1837 Arago prevailed with Metternich to obtain permission for the return of the exile to his home, and in 1839 Melloni was appointed Director of the Cabinet of Arts and Trades at Naples.

"Melloni's discoveries in Radiant Heat began with his first memoir presented to the French Academy, in 1833. This was followed in long succession by others in French and Italian to the day of his death, or for a period of more than twenty years. The fruits of Melloni's labors were systematically embodied in his great work, entitled *La Thermochrôse, ou la Coloration Calorifique*, the first volume of which appeared at Naples in 1850, dedicated to Humboldt and Arago. The title of this work suggests one of the most brilliant, as well as earliest discoveries of Melloni, namely, the existence of variety among rays of heat similar to those peculiarities of light which are called color. As heat itself does not address the eye, so its varieties cannot. The color of heat, as the phenomenon is metaphorically called by Melloni, is not perceived by the eye, but shows itself in the same way that the colors of light appear in experiments on absorption and prismatic dispersion. Moreover, the transcalency of a body is often disproportioned to its transparency. To these researches may be added those on the radiation and absorption, the polarization and depolarization and interference of heat, with incidental investigations in regard to the heat of moonlight and the action of the eye; the whole perfecting and almost creating a new branch of physics, for the complete illustration of which Melloni provided in the world-renowned thermo-electric multiplier and other apparatus as arranged by Ruhmkorff. In view of these great services to science, which have established the undulatory character of radiant heat, whatever may be the statical condition of this force, and have placed the name of Melloni among the highest in physical science, I propose the following resolutions: —

"*Resolved*, That the American Academy of Arts and Sciences has heard with deep regret of the sudden death of its illustrious Foreign Honorary Member, Macedoine Melloni.

"*Resolved*, That the Academy fully appreciates the high services which Melloni has rendered to the physical sciences by his brilliant discoveries in Thermotics, which he has exalted to an eminent rank among the oldest and best cultivated fields of research; and that it recognizes in him, not only an early, long, and deep passion for the study of nature, but also remarkable experimental skill, displayed alike in the contrivance and use of new instruments, as well as unusual caution of mind and excellence of style in communicating his discoveries.

"*Resolved*, That the American Academy unites with the other scientific associations throughout the world in deploring the sudden going down of one of its most brilliant lights, while in its meridian splendor."

These resolutions were seconded by Professor Agassiz, who, together with Professor Gray, offered a tribute to the great scientific eminence and moral worth of the deceased. The resolutions were unanimously adopted.

Professor Agassiz gave the result of some of his recent observations on the phenomena accompanying the first appearance of a circulating system in the higher animals. He remarked, that physiologists had hitherto believed that in Vertebrata the circulation commences by the formation of true blood, flowing from a cavity formed by a group of structural cells which unite to form the heart; its currents, which become gradually inclosed by similar structural cells, forming the bloodvessels. The circulating fluid from the commencement had been regarded as true blood. Recent investigations had convinced him that this is not the case. The primitive fluid in the bloodvessels is not blood, but liquid albumen. This fact he had formerly demonstrated in the embryo chick and turtle, and he had recently noticed it in the embryo of the *Lophius piscatorius*, or Devil-fish. Owing to the transparency of the fluid, the currents were first made out with great difficulty, but, when closely watched, became evident by the separation of particles from the walls of the channels and their circulation in the current, which were distinctly seen. The albumen is that in which the yolk cells of the ovum swim, and the first blood corpuscles are transformed yolk cells. The blood at first contains, besides its proper corpuscles, yolk cells, structural cells, pigment cells, &c. In observing the embryo of *Lophius piscatorius*, while attentively watching one of the primitive isolated currents during four hours, Professor Agassiz saw blood corpuscles starting, and finally a true blood circulation established, where before there had been merely a transparent fluid albumen moving without granules.

Professor Gray presented a short memoir entitled "Note on the Characters and Affinities of *Vavæa*, Benth.; also of *Rhytidandra*, Gray." This paper was referred to the Publishing Committee.

Four hundred and sixth meeting.

November 8, 1854. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Hon. B. R. Curtis, Hon. Rufus Choate, and Rev. Ephraim Peabody were elected Fellows of the Academy in the Section of Philosophy and Jurisprudence.

Dr. Charles E. Ware was elected a Fellow of the Academy in the Section of Medicine and Surgery.

Dr. Thomas M. Brewer and Dr. Silas Durkee were elected Fellows of the Academy in the Section of Zoölogy and Physiology.

Dr. B. A. Gould communicated elements of the fourth comet of 1854, determined from observations at Berlin and Cloverden; — together with the results of some further computations instituted in consequence of the striking resemblance between these elements and those of the first comet of 1845. These results are given in detail in the Astronomical Journal.

Dr. Hayes alluded to the opinion which has been held by some, that after seasons of drought springs flow more freely before rain falls. His attention had been recently called to the subject by hearing, on reliable authority, that in California this phenomenon is observed some weeks before the annual rains. He inquired if any gentleman present could explain it.

Professor Lovering said that in a paper read before the American Association for the Advancement of Science, during the session at Cleveland, this phenomenon had been attributed to variations in atmospheric pressure, such as produce changes in the barometer; and he regarded the explanation as a very rational one.

Dr. Jeffries Wyman stated that he had been engaged in making some experiments with a view to ascertain, if possible, the cause of contractility in some vegetable tissues, as in the capsules of the common Balsam and the *Echinocystis lobata*. In these it is well known that, when the seeds are ripe, the seed-vessel bursts open, scattering them to a considerable distance.

It was Dutrochet's theory, that this action is due to the sudden transfer of fluid from the inner to the outer cells of the wall of the capsule. Dr. Wyman had demonstrated the impossibility of this, by dissecting away the outer layers of cells without impairing at all the contractility of the capsule. He had himself come to the conclusion, that the motion is due to the spontaneous contraction of the cells on the contracting side, in the way that motion is produced in the hydroid polyps. In the contracted capsule the cells on the concave side are found to be shortened, while those on the opposite side are elongated. In the Balsam capsule the contraction is so sudden that the shortening of the cells cannot be watched, but in the Echinocystis the motion is so gradual that the change can be observed under the microscope. When gradually subjected to the action of anæsthetic agents, the capsules lose their contractility; but when suddenly placed under their influence, an immediate contraction is the usual result.

Four hundred and seventh meeting.

December 12, 1854. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Dr. Durkee read a paper on the Common Mosquito, *Culex pipiens*, giving a description of the microscopic structure of its proboscis, with an account of its development and habits of reproduction.

On motion of the Treasurer, the following vote was passed: —

"Whereas, the American Academy of Arts and Sciences has received notice from the executors of the will of the late Samuel Appleton, that they have transferred to this society stocks amounting to ten thousand dollars, from the fund left for distribution by Mr. Appleton, —

"*Voted*, That the Academy accepts with much gratification this contribution to the cause of Science from one who found his happiness in acts of beneficence, and that our thanks are due to the executors of his will for the direction which they have given to his bounty."

Professor J. Lovering made a brief communication, describing new experiments and modes of illustrating the laws of Light and Sound.

"1. At the meeting of the American Association for the Advancement of Science, at Cleveland, in August, 1853, I gave an account of some changes, and, as I believed, improvements, in the construction of Soleil's apparatus for projecting on a screen the chromatic phenomena of polarization. As the volume which is to contain the proceedings of that meeting has been unusually delayed in its publication, and has not yet appeared, I propose to present now to the Academy the substance of my former paper. The apparatus of which I speak, as made by Soleil, is described in Pouillet's *Traité de Physique*, and elsewhere; and a sectional view of it is given on Plate XXXIV., Fig. 21, of the book first mentioned. I here present the apparatus as I have modified it. Soleil's plan is well adapted to many experiments. If the crystal is small, it is placed near the focus of the large lens, which condenses the light upon it and illuminates it strongly, so that the colored rings, black crosses, &c. developed by the analyzer may be projected upon a distant screen on an enlarged scale. But whenever these experiments are to be repeated with crystals of low crystalline power, as quartz, for example, some modification of the apparatus is necessary. Otherwise, it will be impossible to see anything more than the colored centre without the rings. A more diverging beam of rays is required for the rings. Thus have I been led to the construction of another eyepiece, to be substituted in such cases for that which accompanied the original apparatus. It

Fig. 1.

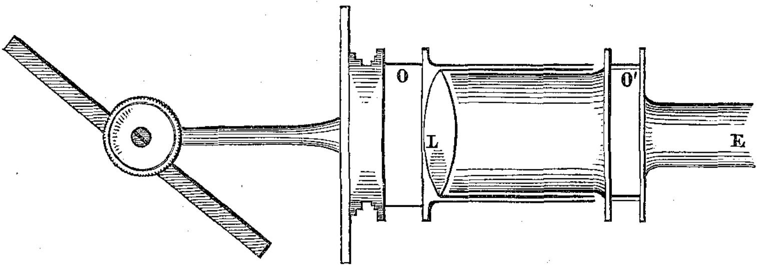
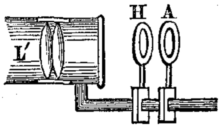


Fig. 2.



is represented in Fig. 2. The two small lenses, L′, having with their united forces a focal length of less than an inch, receive the converging rays as they come from the large lens, L, and make them still more convergent. It is necessary that the quartz should be adjusted very near the focus of the rays, and also that the analyzer should be placed as closely as possible in front of the quartz. Otherwise, this highly divergent pencil of light, after it leaves the focus, will not be able to get through the small area of the crystal and analyzer, and therefore the whole field of view will be curtailed. The crystal and analyzer are held by separate rings, which are supported on uprights which slide independently upon a horizontal bar, and the two rings may, therefore, be pushed as closely together as the thickness of the crystals will allow.

"In Soleil's apparatus, there is an opening, such as is seen at O of Fig. 1, similar to that made in magic-lanterns, and for the same object, namely, the introduction of the frame containing the object to be magnified. When Soleil's apparatus is used for the inspection of large objects, such as pieces of tempered glass or artificial selenite figures, they are introduced at this opening, and in these cases the large lens serves as a magnifying-glass, and there is no condensing lens to help the illumination. This defect would not be felt with very large objects, as large, that is, as the lens itself; because the object itself would receive immediately as much light as the lens could throw upon it. But the objects to be examined are seldom, if ever, of this magnitude. Hence, much of the light which might otherwise be saved, is lost for want of a condensing lens. In order that the apparatus may retain all the advantages which belong to it in its original form, I have retained the opening O, which may still be used in any cases where it is preferred. But the tube which carries the large lens has been divided at the middle of its length, and one part made to slide in the other. Another opening, O′, similar to that in the original apparatus has been joined to one end of the interior tube. By pushing more or less of this tube into the next exterior one, the objects placed in the new opening can be put at smaller or larger distances from the principal lens, which is to this opening an illuminating lens. The best distance, in any given case, is that which makes the section of the cone of rays by the object equal to that part of its own area to be examined. When large pieces of quartz, the tempered glass, or selenite figures, are examined under these circumstances, the superiority of the illuminating arrangement is very decided, and allows of the picture being displayed on a much larger scale than would be otherwise practicable.

"2. Since Newton's prime experiment on the prismatic dispersion of white light, many contrivances have been used to produce the synthetical counterpart to this grand result of experimental analysis. The various methods of uniting the prismatic colors again, so as to restore the white light, are enumerated by Moigno, in his *Repertoire d'Optique*, Vol. IV. p. 1370, as given by Dove.

"It is desirable to obtain the original pure prismatic tints, and then unite the rays, if possible, by some process independent of refraction, and involving no obscure process. Von Münchow does this by giving a reciprocating motion to the prism, and Steinheil, by turning a prism, one side of which is ground or blackened so as to intercept the light, rapidly round an axis parallel to the refracting edge. In either case, as soon as the motion acquires a certain velocity, the colored spectrum vanishes, and a streak of white light appears in its place. This subjective mixture of the colors may be effected in a cheaper manner, by any one in possession of a water-prism, as follows. The light is introduced through one of the inclined glass sides of the prism, at such an angle as to emerge from the upper surface of the water. If the prism stands firmly upon a table, a spectrum will be projected upon the ceiling of the room. But a moderate tap with the finger upon the table will communicate a rapid vibration to the hollow prism, and thence to the water contained in it, and the little change in the refracting angle which ensues will make the spectrum dance backward and forward in the direction of its length. As soon as the dance begins, the spectrum, which hitherto had been of the usual colors, is converted into a long streak of white light.

"3. The only remaining experiment to which I shall allude in this communication carries us out of the province of Optics, and into that of Acoustics. It is well known that, when a tube filled with air is skilfully blown by the mouth at the embouchure, or a vibration in the inclosed column of air is otherwise excited, it is capable of rendering, without any fingering and without holes to finger, a certain series of sounds, which are called *harmonics*. In the humming-top, we may presume that the reaction is the same between the air inside and outside of the top, as it is in the musical pipe: the only difference being, that in one case the air is driven by the mouth against the lip of the embouchure, and in the other the lip of the top is made to strike against the air. I have not been able to find any allusion to the question whether the note which the top yields varies with the force of the blast which the top itself gives by its own motion. But I have succeeded myself in producing two of the harmonics, that is, one besides the fundamental sound. Success in this experiment requires that an extraordinary velocity should be given to the top, greater than is possible except when the top is small. But if a small top is started with great energy, it gives out at first a high sound. As the velocity slackens, this sound dies out, and the top is silent for some time. Afterwards, as the motion diminishes, another and lower sound starts up, which is the one commonly heard in humming-tops, and the only one possible to excite by the usual way of starting the top, if it is large. This curious experiment may be worth recording, as carrying one step further the analogy between the theories of the sounds of the humming-top and of other wind instruments."

Mr. Sherwin alluded to a phenomenon accompanying the recent burning of a large building in Cambridge. The appearance to him, at the distance of several miles, was that of a tall column of light elevated about 20° above the horizon, appearing at first like some extraordinary meteoric phenomenon. It might be accounted for, he thought, by a series of reflections from clouds at different elevations, or perhaps more probably by mirage. In 1811 he had seen a similar appearance 24° high, which proved to have been caused by the burning of a paper-mill forty miles off.

Professor Horsford exhibited specimens of Cochituate water, together with the various products of his recent examination and analysis of it.

Four hundred and eighth meeting.

December 26, 1854. — MONTHLY MEETING.

The Academy met by invitation at the house of the President. The PRESIDENT in the chair.

Professor Felton, at the invitation of the President, gave an account of the present aspect of Greece, from personal observation during a recent visit to that country. He represented its condition as being extremely interesting, from the promise which it gives of literary and scientific development. He spoke of the schools and universities, the public press, the condition of the language, and the prevailing spirit of the people, as giving ground for sanguine expectations of the regeneration of that classic land.

Four hundred and ninth meeting.

January 9, 1855. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. A. A. Hayes read the following paper on the present condition of the Cochituate water, entitled, "On a Remarkable Change which has taken place in the Composition and Characters of the Water supplied to the City of Boston from Lake Cochituate, by A. A. Hayes, M.D., Assayer to the State of Massachusetts."

"In the study of the chemical composition of waters used for domestic purposes, a wide field is open for inquiries of high scientific interest; as the accurate comparisons of different waters lead us through both departments of modern chemistry, the organic and inorganic. This interest is, however, secondary to the importance of careful inquiries in an economical view, as we have actions of waters on substances with which they come in contact at one point, modifying their composition, so as to render them purer, or less salubrious; and when a water passes some distance, its characters may thus be made to differ at different points. Not only is the water changed by different bodies with which it is brought in contact, but conduits of masonry or iron are in special cases rapidly destroyed.

"Although my observations on the water supplied to this city were among the earliest made before its introduction, they have been continued since, and within two years partial analyses have been made almost weekly for the purpose of learning the cause of any changes occurring. The results thus obtained will be given in a future paper, and the conclusions arrived at in a general form, while at present it is my intention to call attention to the condition of the water as it has existed for about ten weeks.

"Cochituate water, derived mostly from surface drainage, as it is found in the pond, or lake, belongs to the class of peaty waters so common in New England. It has not characters in common with the green or colorless waters of limestone formations, nor the medium or mixed qualities of our river waters.

"In its normal state, it may be considered as a pure water, holding in solution four or five grains of mineral salts in one United States standard gallon; and these consist of compounds of chlorine with sodium, potassium, calcium, and magnesium. Carbonates and silicates of these bases exist, in varying proportions, at different seasons.

"Its organic constituents, including the gases dissolved, are those of the most importance, as these give it particular characters, modifying its chemical relations, and affecting the taste, color, and purity of the fluid. In the spring and autumnal seasons there are found ulmic, humic, crenic, and apocrenic acids, and sparingly soluble compounds of these acids and bases, including alumina and oxide of iron. With these is a neutral body, which resembles mucilage from gum, and is usually in a changing state, especially while the water is warm in the summer season. The gases dissolved are oxygen, nitrogen, and carbonic acid; the nitrogen never has the volume relation to the oxygen which exists in air, being, except in rare instances, in smaller proportion, and instances have occurred when the nitrogen was no more than twenty volumes to eighty of the oxygen. The volume of carbonic acid also varies; while about one volume of all the gases exists in thirty-six of normal water. There are present also numerous animalcules and infusoria, fresh-water sponges, and abundance of ochrey matter, resulting from the chemical action of the water on the iron pipes. The animalcules indicate a state, which really exists, of a disturbed balance between the fish, the crustacea, animalcules, and subaqueous vegetation of the lake. Although throughout the year the water, at times increased by rains and melting snow, cannot be classed with putrid waters, there are periods every warm season during which it closely approaches to these in characters.

"In the latter part of October last, I was watching for the increased amount of organic acids due to the decomposition of vegetable matter after a season of drought, succeeded by copious rains, when I was greatly surprised to find the humates and apocrenates giving place to crenic acid and crenates, accompanied by a perceptible odor of decomposing vegeto-animal matter, such as is emitted by freshly disturbed soil. This odor, which characterizes the humus from animal matter, continued several days; the water became colorless, while the organic matter, including carbonic acid, increased so as to exceed nineteen times the minimum amount previously found.

"The condensed vapor from the water had a strong odor of earth, or precisely that of guano from humid climates, and possessed an acid reaction. No more than mere traces of ammonia could be thus detected. When the water was mixed with lime and distilled, the condensed vapor was ammoniacal; proving that no carbonate of ammonia from the soil was present, but a *salt of ammonia*, due to decomposition. The earthy odor, or so-called taste, was succeeded by one closely resembling that of fresh-water fish, which, with slight variations of intensity, has continued nearly ten weeks.

"Before the water throughout the city became thus contaminated, the suggestion arose that the cause was local; the secondary main pipe supplying my dwelling having perhaps retained some decaying parts of eels or fish. A careful examination of the water was made, and by analysis a portion of *oil* was separated from water, which had been filtered through muslin to remove suspended impurities.

"By distillation the odor could be isolated from the water, which thus lost what was pronounced by good judges to be the flavor of fish-oil; while the water retained the oil, almost destitute of odor.

"The general supply of water to a populous city had thus become very offensive, without any adequate cause appearing, and the evil led to the expression of many hypotheses and suppositions, chiefly without reliable support. As the subject was one which was within the reach of experiment, the course adopted was the following.

"A displacement apparatus of glass was charged with recently calcined animal charcoal, of medium fineness; over this was placed a conical filter of clean cotton, so that any water falling on the charcoal would first pass through the cotton filter. The water from a contracted supply pipe was allowed to flow slowly on the cotton filter, and passed away so long as the pores remained open. Removing the cotton filter, the charcoal was allowed to drain, the water displaced by alcohol, and the alcohol by sulphuric ether, without removing the coal. Some oil was found in the alcoholic fluid, while the aqueous ether was colored by it some tint of yellow, to a light olive color. By evaporation at 90° to 100°, the ether left some globules of fluid oil, but by far the larger bulk of residue was a soft solid in granules, without crystalline form. By warming this solid with a little acid, a base was dissolved, generally lime, or lime and ammonia, while the oil floated on the fluid and was left by evaporation of the water. As thus obtained, this oil was of a light yellow color, presenting both oleic and stearic acids. Its specific gravity was the same as that of lard-oil. Alcohol dissolved it without residue. A solution of carbonate of soda saponified it when warmed; proving the acid condition of the oil. With sulphuric acid it blackened, and chlorine changed its color to dark brown. The oil, as separated from the ethereal solution in different experiments, assumed a solid state at 80° or 90° F. Acids eliminated oily fluids constantly, with the emission of a peculiar odor. Treated with carbonate of soda when the soap was decomposed, an odor resembling that from adipocere was perceptible, generally. When the charcoal, while wet from the water, was distilled, the vapor which was first condensed had a strong fish-like odor. It would putrefy and run through the changes, resulting in the production of confervæ.

"The mass of the water supply was constantly changing from its state of approach to putrefactive fermentation — in which free crenic acid and crenates appeared, with a large volume of carbonic acid — to its more nearly normal state. At one time, twenty-eight volumes of water evolved, by boiling, one volume of gases. Twenty-five volumes of the gases were diminished only one volume by phosphorus warmed and left twenty-four hours; or about four per cent. of oxygen, seventy of carbonic acid, and twenty-six of nitrogen. Such a gaseous atmosphere dissolved in the water could not support animal life, in the higher forms of organization. As the oxygen gas increased in volume, the apocrenates and humates appeared, and the water, which had no action on iron, assumed its ordinary action on this metal. The crustacea increased in quantity and size, the cyclops and daphnia became predominant, and the cotton filters were soon closed by their bodies. Attention was now given to the mass collected on the filter, as had already been done with the sponges and some vegetable organisms, including confervæ.

"The fishlike odor was mostly retained by the filter, which had not been the case in the earlier experiments, and it became easy to separate from the gelatinous mass on the cotton the oil with the odor, or apart from it. As separated from this mass, the oil possessed a fugitive green color at times, but the dried filter, extracted by ether, afforded a yellow oil. The variations in color were found to be due to the state of the matter on the filter, which, evidently of animal origin, decayed rapidly, and the oil and odor became merged in a body, much like adipocere. The water which had been purified by means of animal charcoal was free from taste and odor; its vapor did not possess odor, and the larger part of the organic matter had disappeared.

"As the chief contaminating substance in this water was arrested from a current, by even a coarse filter, and the experiments had been repeated so frequently as to leave little else for chemical trials, I placed in the hands of Dr. John Bacon, for microscopical examination, the substance like that from which the odorous oil had been taken.

"Dr. Bacon at once detected the source of the oil, the bodies of the cyclops and daphnia being in large part filled with it. Ten or fifteen globules, of different sizes, could be seen in a single subject; but the most remarkable fact in this connection is the varied colors of the oil. Under the microscope, while many subjects presented a yellowish-brown oil, some were filled with colorless oil, and not a few had oil apparently of a blackish blue, shading to indigo blue. This fact explains the production of green and olive-green ethereal solutions, and it was found that the decomposing remains were often red and yellowish brown, and then afforded light yellow solutions. No substance but those named, and animalcula, was found among numerous collections, which could afford oil; the connection between the chemical proofs and microscopical observations was most skilfully made by Dr. Bacon, in the way of extracting the oil, while the subject was in the field of the instrument.

"At this point in the research, a series of experiments was undertaken which demonstrated that the fluid oil, first obtained by means of animal charcoal, was really due to broken up and dead crustacea, which were then abundant in the water. Certain modifications of the oil, which had been observed, could be traced to the *state* of the mass of the crustacea before the ether was used. As collected at the present time from a portion of water by means of filters of different degrees of fineness, from coarse to very fine, we have the water on one hand free from taste, while the filters retain the matter which rendered the water impure. A portion of this matter placed in pure water gives to it the taste of Cochituate water, while another portion under the microscope presents only living and dead crustacea. Dr. Bacon has kindly recorded his observations, and allowed me to append his account of them to this paper.

"The experimental evidence, having proved the origin of the so-called taste of the water to arise from the presence of an odorous oil contained in the bodies of carnivorous crustacea, there are two practical points to which attention should be called.

"Compared with the water of a pond or lake, where a natural balance exists between the fish, crustacea, infusoria, and subaqueous plants, this water is contaminated by an oily food, which affords subsistence to an unnatural number of crustacea. To restock the lake with several varieties of fish, and by legislative action to protect their growth and increase, seems the proper course to be pursued in correcting the evil. If efficiently carried out, such steps may so improve the quality of the water, that this source of supply will have all the purity of the best known sources, without the variations observed.

"While the impurities exist, it is prudent for families to use for drinking, and, if possible, for cooking, only such water as has been passed through a filter. Even coarse, temporary resorts of this kind will remove much that is offensive, while the better filters will completely purify the water."

Dr. J. Bacon exhibited under the microscope specimens of Cyclops and Daphnia in Cochituate water, containing visible globules of oil, to the great abundance of which was referable the present impurity in Cochituate water, as suggested by Dr. Hayes; and read the following paper, entitled "Observations on the Oil contained in the Crustaceans found in the Cochituate Water."

"The occurrence of numerous transparent globules in the bodies of the minute crustaceans found in the Cochituate water first attracted my notice in the spring of 1854, and I then ascertained by chemical tests that they consisted of oil. Supposing that they were ova in some stage of development, and were probably well known to naturalists, no further observations were made until the bad condition of the Cochituate water attracted public notice; when I called the attention of one of the chemists employed to analyze the water to the presence of this oil, and suggested that it might be the cause of the evil. But it did not appear probable to either of us that a small amount of oil could occasion so serious an effect; and thus the matter rested until the commencement of the present year, when Dr. Hayes placed in my hands for microscopic examination the gelatinous substance collected by him on cloth filters. The microscope revealed an abundance of oily globules in the bodies of the Cyclops and other minute crustaceans, of which the mass on the filter chiefly consisted; and the source of the oil obtained in his experiments was at once evident. At this time (early in January) very few confervæ or other vegetable organisms were found. The empty siliceous shells of various Diatomaceæ were abundant, as usual, but scarcely any specimens were living, or contained organic matter. Yet the peculiar flavor of the water was as strongly marked as in the autumn, when Confervæ and other vegetable organisms abounded.

"The crustaceans in which the oil occurs are several species or varieties of Cyclops and Daphnia, and probably other allied genera of the division Entomostraca. In the living animals, the oil is clearly seen, by the aid of the microscope, through the carapace, which is mostly transparent; and is distinguished by its high refractive power, and other optical characters, from the other contents of the shell. It can also be extracted by ether, and still more satisfactorily by strong alcohol, from the body of the animal, while in the field of the microscope. The quantity present is exceedingly variable, not only at different times, but in different individuals collected at the same time. In a few specimens no globules are visible. In others, they are so abundant that the oil forms at least one quarter part of the bulk of the animal. These large quantities occur only in the Cyclops, which is by far the most abundant form present; the other crustaceans contain much less.

"Its distribution in the body of the animal is remarkable, being diffused irregularly in globules of various sizes (usually spherical and occasionally ovoid or pear-shaped), and in masses formed by the coalescence of globules; and it appears to have no definite connection with the internal organs of the animal. Sometimes small globules are seen, even in the last joints of the tail. No sac or envelope is visible around them, as they occur in the animal, or when liberated by tearing the body into fragments. Yet globules lying in contact in the body do not unite by moderate pressure, but regain their form when the pressure is relieved. A strong pressure causes them to run together. These facts are compatible with the absence of a proper enveloping membrane. No structure of any kind is visible in the globules. Their color, when isolated, is generally orange red or yellow; they range, however, from brownish red to an entirely colorless condition, in different specimens. As the carapace has frequently a tinge of red or green, the color of the oil is of course affected when seen through it.

"Finding that the comparatively large size of the crustaceans allowed of their almost perfect separation from the other bodies suspended in the water, by means of a suitable filter, a quantity was collected from a Cochituate service-pipe, and thoroughly washed with distilled water. They were then introduced, mostly in a living state, into distilled water, in an open vessel. In about half an hour the water began to acquire an odor, and after some hours both the odor and taste resembled closely the peculiar flavor of the Cochituate. In a day or two a decided fishy flavor was developed. The water was now somewhat milky, and on microscopic examination an abundance of colorless oil globules were seen diffused through it, with some gelatinous matter, derived from the bodies of the dead crustaceans, with the fragments of which, together with exuviæ, the bottom of the vessel was covered. A large proportion were still living and active. In about a week, the water began to regain its clearness, and the odor and taste nearly disappeared. Many of the crustaceans were still alive, and it was noticed that a progressive diminution in the general amount of oil contained in their bodies was evident in the successive examinations.

"In the Cyclops, these globules are found equally in both sexes, and cannot therefore be derived from the ova; in many of the females, the granular ova-masses in the internal ovaries are seen in company with the globules, but they are not in connection, nor is there any indication of a transition from one form to the other. In the Daphnia, the small pellucid globules which constitute the earliest stage of the ova, and also the hibernating eggs, are visible in many specimens, and do not resemble the globules under consideration. The male Daphnia is rarely seen, and I do not know whether the oil is found in both sexes, as in the Cyclops.

"Since the above observations were made, I have learned that these oil globules are briefly described by Von Siebold. See Dr. Burnett's Translation of Von Siebold's Anatomy of the Invertebrata, pp. 310 and 334. This author regards them as fat-cells, and, after stating that they occur in many crustaceans, adds the following remarks: 'The fat which these cells contain plays a part, probably, in digestion and assimilation; for with these animals the excess of nutriment is deposited as fat to be used in times of need, as, for example, during the act of moulting. This explains why the quantity found is so variable, or even may be entirely wanting.' I cannot find that they are described by other authors, nor are the appearances which they present in the crustaceans of the Cochituate represented in any of the figures I have seen."

Professor Horsford exhibited the organic matter obtained from thirty-six barrels of Cochituate water; also similar matter taken from the aqueduct above the Brookline reservoir.

Professor Horsford remarked, that the protosalts of manganese are sometimes colorless, and sometimes red. This color has been attributed to a trace of cobalt combined with it, while the pure manganese has been considered colorless. It has been found that the pure ore is in reality red, while, when combined with nickel, the compound is colorless.

Four hundred and tenth meeting.

January 31, 1855. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Dr. Gray presented, in behalf of the author, the following paper, entitled, "Notices of some New Mosses in the Collection of the United States Exploring Expedition under Captain Wilkes, by William S. Sullivant." (Continued from page 81.)

"25. NECKERA PHYLLOGONIOIDES (n. sp.): perpusilla, nitidissima; caule repente radiculoso squamiformi-folioso; ramis vix uncialibus erectis distantibus simplicibus frondiformibus lineari-lanceolatis complanatis; foliis patenti-divergentibus bifariam arctissime imbricantibus lineari-elongatis rectis e basi ultra medium complicatis dehinc exacte

navicularibus extremo apice leniter recurvo brevissime gemello-costatis, areolatione e cellulis minutissimis linearibus, apicialibus rhombeis, basilaribus oblongis amplioribus pellucidioribus. — Hab. Luzon, one of the Philippine Islands.

"26. Pilotrichum Vitianum (n. sp.): majusculum, aureo-lutescens, nitidum; caulibus e basi horizontali radiciformi erectis pinnato-ramosis e flexionis angulo repetito-innovando-continuis primum flagelliformibus, ramis robustis interdum apice attenuato-elongatis et innovando-ramulosis, elongationibus ramulisque rectis gracilibus undique appresso-microphyllis; foliis rameis quinquefariis spiraliter dispositis confertissimis patenti-divergentibus e basi coarctata oblongis subito acuminatis maxime cymbiformi-concavis (cavitate ante basin acuminis longi subserrati undulato-constrictam abrupta profunda) ecostatis compacte angustissime lineari-fusiformi-areolatis, cellulis pachydermibus lutescentibus, inferioribus ad parietes subcrenatis, basilaribus brevioribus puniceis. (Cæt. non lectis.) — Hab. Feejee Islands.

"27. Meteorium Mauiensis (n. sp.): fusco-flavescens et pallide virens; caulibus pendulis flexilibus pedalibus et ultra pinnato-ramosis ramis 1 – 3 uncialibus dissitis simplicibus raro iterum ramulosis flaccidis flexuosis, vetustioribus apice interdum filiscenti-attenuatis microphyllis; foliis indistincte 4 – 5 fariis laxius imbricatis patentibus e basi auriculato-cordata subundulata amplectante oblongo-obovatis obtusissimis breve apiculatis cymbiformi-concavis (marginibus e medio ad apicem late inflexis) scariosis minute areolatis, cellulis subtransversim seriatis lineari-oblongis subparenchymaticis maxime pachydermibus ad parietes interruptis, utraque ala cellulis majoribus subquadratis aurantiacis in orbem majusculum incrassatum dispositis instructa. (Flo. et fruc. non visis.) — Hab. East Maui, Sandwich Islands; on the north bank of the Crater, at an elevation of 10,200 feet.

"28. Meteorium Brasiliense (n. sp.): dioicum: dendrophilum, robustum, nitens, inferne spadiceum, superne luteo-viride; caule primario breviusculo repente tenaci nudo brevissime radiculoso prehensili flexuoso plurimos ramos 2 – 7 unciales fructigeros rigidiusculos dependentes basi appresso-microphyllos simplices vel remote rectangulariter brevi-ramulosos exserente; foliis laxiuscule ubique insertis permagnis trilinealibus (pilo incluso) e basi ampla cordata orbiculari-ovata valde amplexante erecta plus minus horizontalibus oblongo-lanceolatis subtubuloso-convolutis subito in pilum rectiusculum vix denticulatum folio fere duplo longiorem productis, basi obscure brevicostatis membranaceis firmis translucentibus; cellulis valde minutis suo diametro 6–7-plo longioribus lævibus pachydermicis inter se ob parietium meatus appositos veluti subanastomosantibus utriculo primordiali soluto flexuoso instructis lutescentibus, basilaribus profunde rubro-aurantiacis latioribus subquadratis opacis; perichætiis lateralibus sessilibus parvis; foliis perichæt. subecostatis, inferioribus ovatis muticis apice recurvis, reliquiis erectis convolutis oblongo-elongatis obtusiusculis subito longe piliformi-acuminatis, interioribus brevioribus superne pellucide repando-marginatis archegonia 23–28 paraphysibus paucis inter se valde inæquilongis et processibus longissimis piliformibus comitata amplectantibus. (Flo. masc. et fruct. non visis.) — Hab. Organ Mountains, Brazil; on trees.

"29. METEORIUM NITIDUM (n. sp.): dioicum: pallide virens, nitens; caule gracili e basi prostrata ramis æqualibus simplicibus subjulaceis brevibus fructigeris densissime pinnata parce diviso, divisionibus pendulis longissimis flexuosis distanter ramulosis, ramulis cuspidatis sæpe binatim ternatimve fasciculatis; foliis rameis erecto-patentibus e basi angusta oblongo-ellipticis cymbiformi-concavis in acumen longissimum piliforme subflexuosum vix dentatum subito productis membranaceis politis minutissime areolatis, cellulis linearibus, alaribus amplioribus laxioribus subquadratis griseis orbiculariter congestis, costa debili supra medium abrupte desinente; perichætiis lateralibus subsessilibus; capsula immersa cylindraceo-oblonga brevissime pedicellata; peristom. dentibus lineari-subulatis aurantiacis perforatis, ciliis brevioribus (læsis) e membrana angusta ortis; perichætialibus oblongo-convolutis breviter reflexo-acuminatis mediotinus obscure costatis. (Operc. et calypt. non lectis.) — Hab. Vicinity of Rio Janeiro, Brazil.

"30. HYPNUM LIMBATUM (n. sp.): cinclidotoideum, majusculum, fluitans; caule longissimo in ramos elongatos parce ramulosos diviso laxifolioso; foliis humidis siccisve patentibus oblongo- vel lineari-lanceolatis acuminatis modice carinato-concavis interdum subtortilibus, superne serratis costa valida dorso versus apicem serrata percursis, margine ubique incrassato costæformi circumductis densius areolatis, cellulis parenchymaticis echlorophyllosis superne oblongis subopacis utriculo primordiali plus minus conspicuo instructis, inferne lineari-oblongis subpellucidis. (Flo. et fruct. deficientibus.) — Hab. New Zealand; on stones in the bottom of streams."

"31. Hypnum Calderense (n. sp.): robustum, lutescens, nitidum; caulibus prostratis; ramis erectis simplicibus vel parce ramulosis cuspidatis densius foliosis; foliis divergenti-patentibus vel horizontalibus rectis plus minus subconvolutis subellipticis longe lineari-acuminatis (acumine semel bisve torto) superne denticulatis scariosis firmis ecostatis minute areolatis, cellulis linearibus lævibus pachydermibus subparenchymaticis indistincte oblique seriatis, inferioribus subcrenatis, alaribus permultis amplissimis oblongis vesiculæformibus intense aureis concentrice dispositis. (Cæt. desunt.) — Hab. Caldera, Mindanao, one of the Philippine Islands.

"32. Hypopterygium Brasiliense (n. sp.): monoicum, viride; caulibus e rhizomate erectis 1 – 2 uncialibus, inferne simplicibus squamiformi-foliosis, superne in frondem planam erectam pinnatim divisis, ramis simplicibus vel parce ramulosis; foliis paululum imbricantibus valde asymmetricis oblique cordato-ovatis acuminulatis anguste pellucido-marginatis apicem versus argute serratis semi-costatis, costa simplici, minutius areolatis, cellulis æqualibus rhombeis utriculo primordiali soluto subopacis; amphigastriis rotundato-cordatis cuspidatis marginatis vix denticulatis continuo-costatis; capsula horizontali ovali in collum desinente longe rostrato-operculata; calyptra minuta elongato-conica latere fissa rostrum vix tegente; peristomio hypnoideo luteolo binatim ciliolato; pedicellis rubris sparsis longiusculis; perichætialibus ecostatis; antheridiis 7 – 9 majusculis longe pedicellatis; paraphysibus brevissimis 5 – 6-septatis, cellula summa cæteris triplo longiore. — Hab. Organ Mountains, Brazil.

"33. Hypopterygium glaucum (n. sp.): dioicum; H. Smithiano proximum, sed differt statura multo minore; colore glaucescente; foliis (in sicco vel humido) dense subjulaceo-imbricatis fragilibus minus asymmetricis rotundato-ovalibus brevius acuminatis; ramis maxime incurvo-deflexis; amphigastriis pro foliorum ratione majoribus. (Fr. deficiente.) — Hab. New Zealand.

"ALSIA, Nov. Gen.

"Calyptra cuculliformis glabra. Operculum conico-rostratum. Peristomium duplex: exterius dentes sedecem lineali-lanceolati: interius cilia totidem dentibus alternantia filiformia e membrana angusta carinata, orta; ciliolis subnullis. Capsula cylindrica, recta vel subincurva, exannulata, brevi-pedicellata, perichætio elongato emersa. —

Florescentia dioica: flores masc. numerosi. Caulis arcte repens, defoliatus; rami plus minus resupinati, ramulis microphyllis parce breviter subpinnati. Folia ovato- oblongove-lanceolata, lævia, punctiformi-areolata. Habitatio arborea. Habitus perichætium foliorumque areolatio Lasiæ; peristomium calyptraque Leskeæ.

"34. A. Californica: monoica; cæspitibus viridibus extensis bisexualibus; caule arcte repente nudo radiciformi radiculoso ramos 2–3-unciales compressiusculos deorsum directos modice resupinatos ramulis brevibus microphyllis parce subpinnatos paraphyllisque minutis multiformibus instructos edente; foliis laxiuscule imbricatis oblongo-lanceolatis erecto-patentibus vel e basi erecta patenti-divergentibus concaviusculis margine anguste reflexis apice plana indistincte serrulatis vix semi-costatis lævibus, illis ramulorum minoribus gracilioribus, cellulis minutulis rhombeo-rotundatis chlorophyllosis seriatis, mediis basin versus oblongis subpellucidis, alaribus quadratis obscuris; capsula oblongo-cylindracea exannulata breviter pedicellata e perichætio subimmerso gracili elongato exserta rostrato-operculata; vaginula longissime orthotricha; calyptra cuculliformi angusta ad $\frac{2}{3}$ capsulæ descendente glaberrima; perist. dentibus lineali-lanceolatis remotius prominenter trabeculatis inferne flavescentibus striolatis superne griseis punctulato-scabris linea divisuriali conspicua notatis, ciliis fere æquilongis subuliformibus nodoso-articulatis scaberulis basi membrana angusta plicata transversim oblongo-areolata connexis; perichætialibus vaginantibus, superioribus filiformi-acuminatis pedicellum æquantibus: flo. masc. gemmiformibus valde manifestis tota caulis ramorumque longitudine utrinque crebre dispositis; antheridiis 4–6 paraphysatis. — Neckera Californica, *Hook. et Arn.; C. Mull. Syn. Musc. Frond.* 2. p. 117. — Hab. California; on trees."

George Livermore was elected a Fellow in the Section of Philology and Archæology.

Professor Horsford read a joint communication by Professor Frederick Wöhler of Göttingen and John Dean, on Tellurmethyle.

Professor Agassiz made a communication on the alternate generation of *Oceania tubulosa* and *Thaumantias*, showing that they arise from polyp-like stalks, known as Syncoryne and Campanularia, and mentioning some interesting partic-

ulars concerning these Medusa-like forms, which he proposed to embody in a paper to be presented at a future meeting.

Professor W. B. Rogers made a communication on the subject of binocular vision, giving his own explanation of the phenomenon, and illustrating it by the aid of the stereoscope.

This communication was followed by remarks from Professor Agassiz, Dr. Pickering, Dr. W. F. Channing, and the President, on various phenomena connected with the laws of vision.

Dr. Durkee exhibited filterings from the water of a lake in Haverhill, showing animal forms containing oil, similar to those found in Cochituate water at the present time.

Four hundred and eleventh meeting.

February 13, 1855. — Monthly Meeting.

The President in the chair.

Mr. G. P. Bond presented, in behalf of W. H. Emory of the U. S. Topographical Engineers, a paper, entitled,

"Discussion of Observations for the Isodynamic, Isogonic, and Isoclinal Curves of Terrestrial Magnetism on and near the Line of the Boundary Survey between the United States and Mexico, made in 1849, 1850, 1851, and 1852, under the Orders of Major W. H. Emory, Astronomer of the Boundary Commission," — being a continuation of the article on the same subject in Volume V., page 1, of the Academy's Memoirs.

Mr. Bond also exhibited some diagrams of the planet Saturn, and mentioned various facts concerning it; namely, that the inner edge of the rings is constantly approaching the planet itself; that the ball is seen through the rings, which are consequently transparent; that the color is different in different parts of the rings, the equatorial regions being white, the temperate region reddish, and the polar bluish. He also mentioned that the shadow of the ball upon the ring can be seen on both sides of it, being on one side rather faint, but on the other quite decided. This anomalous appearance he first noticed in October, 1852, and as yet he could give no satisfactory explanation of it, nor of the singular shape of the shadow, the convexity of which was towards the ball, instead of from it, as it might be expected to be. His observations were made with the great Cambridge Refractor in the years 1852, 1854, and 1855.

Four hundred and twelfth meeting.

March 13, 1855. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Lovering alluded to the fact, that at a previous meeting the opinion of Arago had been referred to as favorable to making the subject of "Table-moving," so called, a matter of scientific investigation. Since that meeting he had himself examined the new edition of Arago's complete works, and had found nothing to justify such a conclusion; on the contrary, he found that Arago declared himself satisfied that the appearances in question are founded in imposture.

Four hundred and thirteenth meeting.

April 10, 1855. — MONTHLY MEETING.

The PRESIDENT in the chair.

After the record of the preceding meeting was read and approved, Professor Agassiz confirmed from his own knowledge the statement of Professor Lovering at the preceding meeting concerning Arago's opinions of the so-called "Spiritual Manifestations." And yet, he said, notwithstanding the unanimous opinion of the committee of the French Academy, to which the subject had been referred, that the whole thing is a matter of imposture, the authority of that learned body and that great philosopher is constantly appealed to as favorable to the alleged reality of the appearances in question.

Professor Agassiz made a communication on the subject of the classification of Polyps. He remarked that Cuvier included under Polypi what are now known as Hydroids and Bryozoa. Milne-Edwards has demonstrated that the latter are not Polypi, — their structure not being truly radiate, — but the lowest order of Mollusks, and he called them Molluscoids. Polypi and Hydroids, however, are still grouped together. By Ehrenberg these are called Anthozoa, — which he divides, further, into two groups: Zoöcoralia those which are free, and Phytocoralia, those which are attached; but under these groups he has made a very unnatural distribution of the families, as the young and adult of the same species may differ in this respect, the young being sometimes attached, when the adult is free. Professor Agassiz exhibited in illustration a specimen of *Manicina areolata* from Florida, the young of which are sessile, whilst the adults are free. Milne-Edwards subdivided Polypi into Actinoids, Alcyonoids, and Sertularians, which he considers as coequal groups, a division chiefly based on the character of the tentacles and calycle; but Professor J. D. Dana has at last shown that the first two form one natural group, and the Sertularians another, thus for the first time uniting the types of the class of Polyps together into one division. Professor Agassiz is however of opinion, that the Hydroids should be removed from the class of Polypi, and referred to that of Acalephæ. They are pedunculated Medusæ in the same sense that Crinoids are pedunculated Asteroids. The true Polypi are divided by Dana into two orders, the Actinarians and Alcyonoids. Professor Agassiz thinks he has detected indications of superiority and inferiority of structure between these orders, founded on the structure and number of the tentacles, &c. Thus in Alcyonoids these are fringed and definite in number and position, being two in the long axis, and in three pairs on the sides, while in Actinoids they are simple, and there is not the same regularity of number and position. The former should therefore be regarded as ranking higher than the latter. Among Actinoid Polyps some are simple, while others are compound individuals. The former would at first seem to stand highest in the scale, whereas they are in reality the lowest, as their tentacles are indefinite in number. Among the Actinoids there are species provided at first with one mouth, which afterwards contracts and divides into two, each being surrounded by its row of tentacles, the animal being thus double above, but single below; and the division may be repeated, so that the number of mouths shall be four, belonging apparently to as many individuals, while in reality they are but one, being united below. The multiplication is indefinite in many types. Such a peculiar structure naturally leads to the question, What defines the individual in this case, — the possession of a single mouth, or the union of all the branches below? In Meandrina a number of mouths are surrounded by a single row of tentacles, and there is one common digestive cavity. In a Madrepore, which has sprung from a single egg, the main polyp may preserve its position at the top of the stem, while buds are pushed out from the stem, constituting a community of individuals subordinate to the principal one. This shows distinctly that polyp communities are combining into higher unities. Among some of the Alcyonoids, as in Renilla, Pennatela, &c., a community of individuals based upon a single stem, each polyp being provided with its own set of tentacles, and all communicating with a common cavity, has the power of changing its position and moving about freely, exhibiting a new kind of individuality, a community moving as a single individual. Among the Polypi, then, the compound individual presents the higher type, and Alcyonoids, which are all compound animals, are higher than Actinoids, among which alone simple polyps are found. This position accords with the revelations of geology, the former never occurring as fossils in ancient formations, while the latter have built up all the coral formations of past geological epochs. Dana has shown that the Actinoids bud in two ways, some dividing at the top, others budding laterally. Professor Agassiz regards the Madrepores as the highest, on account of their tentacles being definite in number, and some preserving a top animal; next he places the top budders (Asteroids), while those that bud laterally (the Caryophyllians) rank lowest. This order of arrangement corresponds in general to the geological succession of Polypi from the lowest formations upward. Again, every coral reef rising from the bottom of the ocean shows in its various stages a succession of species reminding us of the same general plan.

Professor Agassiz remarked, that the study of this class of animals is greatly embarrassed by difficulties growing out of the fact, that the general features vary much in communities of the same species, so that these features cannot be so much depended upon for characters as the intimate structure of the individual polyps. He was inclined to believe that many of the genera of this class recently described by naturalists are based on evanescent characters, in fact upon different stages of development of well-known types.

Dr. A. A. Hayes called the attention of the Academy to a new species of wax, a specimen of which was on the table, and made the following remarks: —

"The commercial relations of our country, extending along the rivers of South America, are making known to us the products of the vast forests of the interior, many of which have a high value in the arts and are new to commerce. Among specimens received by me is the peculiar wax before us, respecting the origin of which I possess only a meagre amount of information. 'It is obtained by boiling the deep green leaves of a shrub resembling laurel, abounding in the forests back from Para and Bahia, and is used to some extent as a substitute for wax in the manufacture of candles.'

"This wax has a light tint of greenish-yellow color, transmitting nearly white light through thin portions; it is hard, the angles of the fragments scratching gypsum. Its fracture is slightly conchoidal, lustre more dull than that of ordinary wax. By rubbing, it becomes electrically excited, and takes and retains a fine polish; it is brittle, without softening when compressed between the fingers.

"The average sp. gr., determined on many specimens, is at 60° F. 1.000, or the same as distilled water. When heated to 120° F. for some time, it loses moisture, and exhales a pleasant balsamic odor, not unlike that of pinks.

"100 parts at 212° F. became a transparent fluid after frothing, having lost 2.10 per cent of volatile matter, this being mostly aqueous moisture due to the process of manufacturing it, and the dry wax on cooling becomes slightly darker in color. Made into candles, it burns with a deep opaque yellow flame, a thin stream of smoke creeping from the apex; its decomposition in this way showing an excess of carbon, as the carbo-hydrogens burn in the air. This important character forbids its application as a substitute for wax, or for affording light in confined spaces; otherwise, its high melting-point would render it very valuable in many situations, when our ordinary materials fail. When mixed with tallow, the latter becomes harder, and the *apparent* melting-point of the mixture is higher than that of tallow. But the resulting mixed mass softens at a temperature of 100° F., and the new wax does not break up in the act of combustion, so as to unite with the carbo-hydrogens of the tallow, with which it is mixed. Its application in this way does not therefore promise a valuable result.

"Alcohol of sp. gr. 0.821, when boiled on the dried wax, dissolves a small portion, which separates in part by cooling, in the form of a hydrous mass, becoming white. The cold solution evaporated disengages a balsamic odor; the coating it leaves, when dry, has the characters of the original wax.

"In sulphuric ether, the same characters are preserved, the matter dissolved being identical with the original wax.

"Benzole is the appropriate solvent for this wax; it melts in it, dissolving largely, so that on cooling the solution becomes a soft mass. A more dilute solution allows the pure wax to deposit in beautiful snow-white granules, which, while wet, are transparent, becoming opaque on drying. These granules when magnified appear generally to be composed of aggregations of spherules, forming mammillary concretions; but in rare cases radiating lines occur within them, indicating the existence of a polarizing force too feeble to form a rectilinear solid.

"Chloroform dissolves the wax freely, and the results of cooling and evaporation are the same as occur with benzole.

"These characters sufficiently prove that this wax does not, like many other kinds, divide into a more fluid and a more solid body, when subjected to the action of solvents; and its unity in this respect is its most strongly marked peculiarity.

"In alkaline solutions, by ordinary treatment, no saponification takes place, after long boiling. The wax retains a little alkali after it has been washed in water, and the compound is to a small extent soluble in water, but has not the characters of soap. This alkaline wax will absorb a considerable quantity of an alkaline solution, in which it has been boiled; washing in water removes the excess of alkali, no definite compound being formed.

"When distilled from a nearly closed vessel, it leaves 0.44 per cent of carbon and ash, the latter amounting to .10 only.

"This wax can be supplied, should a want exist commercially, at a price intermediate between that of tallow and the ordinary wax. The only application at present known in which it exhibits useful properties is in forming a basis for a preparation used in waxing furniture and polished wood-work."

Mr. J. H. Abbot exhibited profiles of two routes for the Pacific Railroad, drawn by order of government; also profiles of the highest grades of all the working railroads of the United States. He also exhibited a mineral from a digging in California, taken twenty feet below the surface. It was a remarkably pure specimen of *hydrate of alumina*, with a minute quantity of *hydrate of silica*.

Mr. T. S. Hunt made a communication on the chemical law of equivalent volumes. He showed that the law applies to all solid bodies that are homœomorphous.

Dr. Durkee exhibited under the microscope the circulation of the contents of the cell of *Chara*.

Four hundred and fourteenth meeting.

May 8, 1855. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Agassiz stated that, since the preceding meeting, he had received one hundred and fifty specimens of one and the same species of coral, *Mussa angulosa*, Oken, the examination of which had satisfied him of the truth of his observations at the previous meeting, that many of the species described by authors are but immature specimens of species passing under other names. Dr. A. A. Gould, who had examined the specimens, confirmed Mr. Agassiz's statement.

Dr. C. T. Jackson read the following extracts from a letter of M. L. Elie de Beaumont to himself, dated Paris, March 23d, 1855.

"You will see in the *Comptes Rendus*, that M. Gaston Planté has discovered at Meudon, near Paris, the remains of a gigantic bird, which is nearly as large as those which left their foot-prints in the new red sandstone (*Gres bigarrés*) on the borders of Connecticut River. This unexpected discovery will perhaps excite an interest among American geologists, inasmuch as it will diminish the incredulity with which many persons have opposed, during a long time, (and erroneously as I think,) the interesting discovery of Ornithichnites. . . . . .

"We have established in Paris a *Meteorological Society* on a plan analogous to that of the Geological Society, and shall seek to bring together and publish and compare the meteorological observations made in all countries of the world; and shall be very happy to have collaborators in America, and to exchange publications with the Scientific Societies of Boston."

Professor Agassiz said that he was inclined to doubt whether all the so-called footprints of birds in the Connecticut River sandstone, were in reality produced by birds. Possibly they may have been made by animals of a type not now existing, in their organization coming between reptiles and birds. He was inclined to this opinion, from having noticed that in many of the tracks the impression of the so-called hind toe is rounded off, without any trace of the imprint of a nail, giving it much more the appearance of a heel-mark. Among the impressions, that of a so-called tarsus is apparent, and it is an unusual circumstance for birds to support themselves upon this joint in walking; the only species in which this takes place being the Cypselus, or Swift.

Professor O. W. Holmes exhibited a new microscope by Nachet, constructed upon a very small and compact scale, and yet available for working purposes, the highest power being about six hundred diameters.

Mr. G. P. Bond stated that he had found that the horizontality of the axis of the Great Equatorial at Cambridge is subject to a regular disturbance, its position going through a succession of changes almost uniform every year. This he ascribed to the unequal action of temperature upon the two supporting pillars. The western pier rises from March to September, and is depressed during the remainder of the year. Mr. Bond exhibited a diagram, showing by a series of curves the rate of elevation and depression through different months, for the past five years. The amount of departure from a horizontal position is $\frac{1}{1000}$ of an inch in all.

Mr. Bond also said that he had been making some investigations to ascertain whether the attraction of the moon has any effect on the motion of a pendulum, and consequently upon the rate of a clock. He had found this last to be changed to the amount of $\frac{3}{1000}$ of a second daily. At the equator the moon's attraction changes the weight of a body only $\frac{1}{7000000}$ of the whole; yet this force is sufficient to produce the vast phenomena of the tides.

Four hundred and fifteenth meeting.

May 29, 1855. — ANNUAL MEETING.

The PRESIDENT in the chair.

The Treasurer presented his report for the year, which was certified by the Auditing Committee.

The Committee on the Library reported, and their report was accepted.

Professor Agassiz referred to the allusion in the Report to the Smithsonian Institution, and expressed in strong language his sense of the indebtedness of the scientific world to that Institution for its enlightened efforts to diffuse knowledge, particularly as a medium of exchange of publications. In conclusion, he moved that the thanks of the Academy be presented to the Smithsonian Institution, for its efficient agency in effecting for the Academy its exchanges with foreign

Societies and individuals. The motion was unanimously adopted.

Professor Lovering made a report in behalf of the Committee of Publication.

Francis C. Gray, Esq. called the attention of the Academy to the proposed work of Professor Agassiz on American Natural History. He made an earnest appeal in its behalf, urging gentlemen to individual effort to obtain subscribers, as in no other way could so expensive an undertaking be carried through. Six hundred subscribers, he stated, would be necessary to pay the mere cost of the work. His remarks were seconded and enforced by the President.

Mr. Francis Parkman was elected a Fellow of the Academy, in the Section of Political Economy and History.

The Corresponding Secretary announced the decease of the following members of the Academy during the past year: —

Foreign Honorary Members.

Prof. Carl Friedrich Gauss,	Göttingen.
Macedoine Melloni,	Naples.
Sir Henry de la Beche,	London.

Associate Fellows.

Prof. J. P. Norton,	New Haven.
Dr. R. M. Patterson,	Philadelphia.
Dr. N. Drake,	Cincinnati.
Prof. J. L. Kingsley,	New Haven.

Resident Fellows.

Dr. W. I. Burnett,	Boston.
Dr. Samuel Parkman,	Boston.

Dr. B. A. Gould, Jr., addressed the Academy in relation to the recent calamity which had befallen Science in the death of Gauss, and concluded by offering the following resolutions, which were seconded by Professor Lovering, and unanimously adopted: —

"Whereas this Academy has recently received intelligence of the afflictive event which has deprived it of its illustrious Foreign Member, and the world of a great master in mathematical, astronomical, and physical sciences, —

"*Resolved*, That the American Academy of Arts and Sciences would unite with other learned institutions throughout the world in expressing its sense of the immense loss sustained by Science in the death of Carl Friedrich Gauss.

"*Resolved*, That the Academy has regarded with pride and admiration the long and brilliant scientific career of the venerable 'father *of sciences,' whose usefulness has been permitted to extend to the* last hours of a life longer than is ordinarily permitted to mortals, although it closed with the full brilliancy of its noon.

"*Resolved*, That the Academy offers its condolence to the bereaved family of the illustrious dead."

Dr. C. T. Jackson exhibited drawings of a microscopic view of a fungus on the surface of a yellow rose.

Dr. Jackson also read the following analysis of water from the Sacramento River, California.

"7 cubic centimetres, equal to 2½ fluid ounces nearly, gave of solid matter 0.4 grains. This was found to consist of

Silicic Acid, ...	0.08
Soda and Chloride of Sodium, . .	0.22
Sulphate of Soda, ...	traces.
Organic matter, ...	0.10
	0.40

This water contains no salts of lime."

The election of officers was held in the usual form, and the following were chosen: —

JACOB BIGELOW, ...	*President.*
DANIEL TREADWELL, . .	*Vice-President.*
ASA GRAY, ...	*Corresponding Secretary.*
SAMUEL L. ABBOT, . . .	*Recording Secretary.*
EDWARD WIGGLESWORTH, .	*Treasurer.*
NATHANIEL B. SHURTLEFF,	*Librarian.*

The following gentlemen were chosen Members of the Council for Nomination, viz.: —

Joseph Lovering,
J. I. Bowditch, } of Class I.
Benjamin A. Gould, Jr.
Louis Agassiz,
John B. S. Jackson, } of Class II.
Jeffries Wyman,
James Walker,
Jared Sparks, } of Class III.
Nathan Appleton,

The several Standing Committees were appointed, on nomination from the chair, as follows: —

Rumford Committee.

Eben N. Horsford, Joseph Lovering,
Daniel Treadwell, Henry L. Eustis,
Morrill Wyman.

Committee of Publication.

Joseph Lovering, Louis Agassiz, Francis Bowen.

Committee on the Library.

Augustus A. Gould, Benjamin A. Gould, Jr.,
J. P. Cooke, Jr.

Auditing Committee.

Charles Jackson, Jr. Thomas T. Bouvé.

Four hundred and sixteenth meeting.

August 8, 1855. — Quarterly Meeting.

The President in the chair.

The Recording Secretary read a communication addressed to him by J. J. Dixwell, Esq., requesting in behalf of Dartmouth College that the Publications of the Academy be presented to that Institution.

On motion of Dr. A. A. Gould, seconded by Professor Asa Gray, it was voted, that, in accordance with the request of Mr.

Dixwell, the new series of the Academy's Transactions be presented to Dartmouth College.

Four hundred and seventeenth meeting.

September 11, 1855. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

Professor Joseph Henry, of the Smithsonian Institution, addressed the Academy on the subject of the induction of electrical currents at great distances from the primitive current, and on the oscillating movements which he had detected in these currents, giving a positive or negative character at any given point at different times. He also gave an account of the numerous experiments he had made to establish the facts which he had announced.

Dr. A. A. Hayes remarked, that

"The facts communicated by Professor Henry are of high interest and importance, in their bearing on any theory of electrical action. The phenomena presented in the observations of Professor Henry correspond, in a remarkable manner, with those taking place when a hydro-electric current acts on a conductor of the first class. In the case of a continuous polarization, the central parts of such a conductor exhibit no power of decomposition, even when the current is feeble. A simple experiment, which illustrates this condition of a polarized conductor, may be made by immersing a curved wire in a solution of metallic salt, the metal of which can be displaced by the metal of the curved wire. If a wire of soft bright iron, bent in the form of a horseshoe magnet, have its bend barely dipped into an acidulated solution of sulphate of copper, the copper will be deposited on it as it would be on a straight wire. But if the curved wire be lowered into the solution, or if at first it be at once immersed, the deposition of copper by displacement occurs at the free extremities of the wire and extends towards the bend from them. It ceases, however, before it reaches the bend, or central part, which never receives more than the slight coating due to the instant exposure in immersing it. This experiment may be varied by modified curves of the wire; but however numerous the forms of the bends, the central part of each wire or plate is null in its action as an electrode."

Dr. A. A. Hayes read the following communication on a specimen of native iron from Liberia, Africa: —

"It is with pleasure that I submit to the inspection of the Academy a specimen of native iron from Liberia, believed to have been taken from the tract of country bordering the St. John's River, recently acquired by the New Jersey colony. This specimen was placed in my hands by Rev. Joseph Tracy, Secretary of the Massachusetts Colonization Society, for examination, and its physical characters at once arrested my attention, as differing from those of any artificially produced iron. As I deem the discovery of native iron existing unalloyed a matter of much interest to naturalists and chemists, it is proper that the evidence on which the statement rests should be submitted somewhat in detail. In the African Repository, Vol. XXX. No. 8, August, 1854, at page 240, is a letter from Rev. Aaron P. Davis, a resident missionary at Bassa Cove, from which the following extracts are taken. 'I send you a piece of African *ore*, just as dug from its native bed, or broken from among rocks. I have seen and conversed with a number of natives, who affirm that it is actually the pure ore, or just as taken from its native bed. I obtained a piece through Hon. George L. Seymour, who had tried in vain to dissect it: and I being of that craft, he brought it to my shop for that purpose. When he brought it, it appeared like a craggy rock, of yellowish color on its surface, and, with a very small exception, it could not be separated but by heat and hard pounding with my largest sledge-hammer and a chisel prepared for the purpose. I also send you a teaspoon which I made of some of the ore, which in its crude state is superior to the iron brought here for sale by English merchant-vessels.' 'I am told by the natives that it is plentiful, and about three days' walk from our present place of residence (Bassa Cove): it is gotten by digging and breaking rocks. It is also said to be in large lumps. In these parts the natives buy no iron, but dig it out of the ground, or break the rocks and get it, as the case may be.'

"The largest specimen before you, when received by me, bore on one side the impress of the chisel, the coarse fracturing of a tough metal, and marks of oxidation by fire; it was further identified by William Coppinger, Esq., of Philadelphia, as the piece received with the letter of Mr. Davis. Mr. Coppinger gave the specimen to Rev. H. M. Blodgett, who sent it to Rev. Joseph Tracy, from whose hands I received it. Soon after I had expressed to Mr. Tracy my belief that the specimen was native iron, he placed before me a large amount of written evidence, showing that malleable iron, sufficient in quantity to meet the wants of the natives, is obtained by heating and then by fracturing the rocks of the country. The writers use the term *ore* incorrectly, as Mr. Davis does, apparently in the belief that iron ores increasing in richness become malleable. The metallurgical knowledge of the natives is so limited, that they are unable to produce copper from the carbonate of copper (malachite), which they carry five or six hundred miles as a medium of traffic; while their weapons of iron, which I have examined, show the characters of native iron, after it has been heated and hammered.

"*Physical Characters.* — On developing the internal structure of the mass of iron, by immersion for a few moments in strong nitric acid, and immediately after washing in a mixture of lime and water, it was apparent that the minute crystalline particles were arranged in a manner closely resembling those of the pure iron * in meteoric iron, and entirely unlike the particles in artificial iron.

"Where the mass had been heated, and had received blows, there was an approach to the appearance presented by artificial iron, but the internal parts, and nearly the whole of the mass, showed no marks of percussive or laminating action. By the more complete development of the structure, certain points appeared which were evidently extraneous matter. Under the microscope these points showed crystalline minerals, which when separated proved to be quartz and octohedral oxide of iron. A mineral with a lime and soda base was also found. The iron was most readily acted on by chemical agents, where it was in contact with these minerals; exposure of a surface to the action of an acid not only brought them to view, but produced cavities at the points where they existed; showing degrees of porosity influenced by their number.

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* "The character which is here noted has a higher value in a research of this kind, than would have been inferred from a cursory examination. In a description of the remarkable meteoric iron, published in the American Journal of Science, November, 1844, I alluded to the fact, that these masses are not made up of iron alloyed with nickel and other metals, but consist of *pure iron,* through which are mixed portions of an alloy of nickel and iron, and iron and nickel and other bodies, as distinct *electro-negative* matter, in relation to the pure iron. The Texas meteoric mass and the small particles of the Western meteorolite had the same mechanical constitution. Since the first publication of my results, these researches have been extended, so as to include the metals of commerce and the well-known alloys. The numerous analyses made on these forms of matter have not yet shown an exception to the condition, that the metal existing in the largest proportion is in part pure; while one, two, three, or more alloys may exist, distributed through it. When we take the results on a mass of crude iron in the state of pig-iron, and on portions of the less and more malleable iron, of the different steps of the manufacture, we not only pursue the constituents chemically, but the mechanical state of the iron is at the same time open to view. A mass of pig-iron thus becomes associated with meteoric iron, in the mechanical arrangement

"The sp. gr. of the most compact portion was 6.708. Its color was lighter gray than any sample of artificial ductile iron I have seen. Repeated bending back upon itself did not separate one fragment, but generally flaws appear and thin portions break when doubled close. The presence of the minerals imbedded is felt, when we file or saw the metal; but when heated and hammered, these fuse into slags, and the metal spreads and draws off, like the best irons, yet showing the cavities and flaws where the simple minerals had existed.

"*Chemical Characters.* — It dissolves with effervescence in diluted hydrochloric acid, and if the acid and water are perfectly pure, the evolved gas has no odor. 200 grains were dissolved in hydrochloric acid, the hydrogen gas was passed through pure alcohol kept cool, and was then allowed to bubble through an ammoniacal solution of nitrate of silver. The alcohol had not acquired odor, nor was there any coloration or change in the silver solution. The solution of iron was turbid, but soon deposited suspended matter, which was light-gray colored; some heavy white sandy grains, and some dark, nearly black particles, had fallen. After collecting and drying these substances,

of its parts, and generally consists of perfectly pure and malleable iron, disturbed in the arrangement of its crystalline particles by the interposition among them of a compound of iron and carbon and of graphitic carbon, besides sulphides, phosphides, and arsenides of the alkaline metals. In the ductile iron, these bodies have been nearly all removed by heat and mechanical operations, and new features impressed upon the metal. By simply removing the interposed foreign matter, by chemical means solely, crude iron is left malleable, and its particles then show their sub-crystalline forms, but not as they exist in the pure iron of the more perfect meteoric masses. All manufactured iron presents them arranged in lines and interlaced by the action of the hammer, or extended in bundles in the act of drawing; while the laminating mill breaks them down, shingling them over and felting together their serrated edges, in striking analogy of effect to the operations of textile manufacturing. The mechanical texture of a mass of iron cannot be shown fully by the simple step of immersion as above given, but this is sufficient to enable one to observe whether the crystals have arranged themselves as aggregates, or been broken up and disturbed by violence, and often will serve to show the kind of mechanical action employed."

they were placed under the microscope, which showed the heavier bodies to be quartz, with some facets and fragments of octohedral crystals, proved to be magnetic iron-ore. The light body was silicic acid, rendered gray by iron oxide.

"Chlorine was passed into the filtered iron solution, which, after being heated and cooled, was precipitated in a partly closed flask, by gaseous ammonia passed into it in excess. After being heated by a vapor-bath, the precipitate was separated by filter and washed.

"The filtrate and washings evaporated were reduced to a dry mass, which afforded a minute quantity of soda and lime: no other substance was present.

"Separate parcels of the precipitate by ammonia were used for the detection of Phosphorus, Arsenic and Boron, Alumina, and other earths and oxides: a little silicic acid only was found.

"50 grains of the filings of the iron were wet with a few drops of perfectly caustic soda solution, mixed hastily with crystals of pure nitrate of soda and chlorate of potash, and heated in a nearly closed platina crucible rapidly to bright redness twenty minutes: no deflagration occurred and the fused salts were colorless.

"The crucible, after cooling, digested in a closed vessel with recently boiled pure water, gave its soluble part to the water. After subsidence, the clear fluid was added to a dilute saturated solution of lime in ammonia in one vessel, and to a dilute solution of baryta in another. These vessels were closed, and left twelve hours, and then presented nearly transparent solutions; no precipitates had fallen, but both showed the presence of silicic acid. The absence of sulphur and carbon was thus proved, and other trials confirmed these results.

"*Analysis.* — In the following analysis, and in repetitions, different slabs of the metal were used, so as to obtain an average percentage composition of the mass.

"A solution in pure water of about one hundred and fifty grains of pure sulphate of copper was used as a medium in which the iron dissolved replaced by electrolysis the copper deposited on the negative electrode of platinum connected with a small constant battery.

"26.30 grs. of iron solved in the fluid and 29.78 grs. of copper were deposited on the platinum, while 0.32 gr. of matter was precipitated.

"The equivalent of pure iron being 28, the deposit of copper should have weighed 29.71; an accordance as near as the experiments allow.

" 0.32 gr. of matter consisted of angular portions of quartz, fragments of crystals of magnetic iron-ore, and a flock of silica: no trace of carbon was observed under the microscope.

" 26.60 grs. was the total loss from the iron.

" The partly ferruginous solution decomposed by an excess of hydro-sulphuric acid, evaporated and calcined, afforded barely traces of lime and soda, which in every case have been found to result from the solution of this iron.

" 100 parts of a sample of this iron, therefore, consist of

Pure iron, ...	98.87
Quartz, iron ore, and silicate, . .	1.13
	100.00

" Another sample, more nearly an average, from the centre of the mass, afforded in 100 parts,

Pure iron, ...	98.40
Quartz crystals, magnetic iron ore, and silicate of soda and lime, . . .	1.60
	100.00

" The little slabs which had been the positive electrodes had not disengaged a bubble of gas, which always occurs when the metals affording alkaline bases are alloyed. They also exhibited in their substance the cavities which had contained the mineral bodies found.

" I was desirous of making some comparative experiments on a specimen of iron having the characters of native iron, as distinguished from meteoric iron. My friend, Professor B. Silliman, Jr., kindly supplied me with two slips from the specimen well known as having been found at Canaan, Conn. He expressed to me at the time a doubt respecting the certainty of this mass being native iron.

" On subjecting this specimen to analytical trials, it was soon determined that it is an alloy, consisting of iron, iron and carbon, and pure graphite.

" 100 parts afforded

Pure iron, ...	93.057
Carbon, ...	2.666
Iron from carbon, ...	1.361
Graphite, ...	2.916
	100.000

"In the arrangement of the alloy of carbon and iron, and the lamina of graphite, it differed in no respect from 'Kishy' iron which has been allowed to repose in a heated state, and is unquestionably an artificial iron, — a product of the blast furnace."

Professor Agassiz said that he had received, through the kindness of Dr. Green, of Commodore Perry's Japan Expedition, the bag containing the immature young of a viviparous fish from Japan. He regretted that the whole of the parent fish had not been preserved, but he hoped to be able from the embryos to make out the characters of a new genus, which may be regarded as the Asiatic representative of this interesting type. The specimens were from the shores of Simoda.

Professor J. P. Cooke gave in detail the processes by which he had obtained perfect octohedral crystals of arsenic. He was led to do so by the fact that their genuine character had been called in question.

Dr. A. A. Hayes confirmed, from his own knowledge, the fact of the production of such crystals in other ways.

Four hundred and eighteenth meeting.

October 9, 1855. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Recording Secretary, in behalf of the author, presented the following paper, viz.: "Descriptions of New Species of Fossils, from the Cretaceous Formations of Nebraska, with Observations upon *Baculites ovatus* and *B. compressus*, and the Progressive Development of the Septa in Baculites, Ammonites, and Scaphites. By Professor James Hall, of Albany, N. Y."

Professor J. P. Cooke exhibited and explained a printed chart of his classification of the chemical elements. The plan was the same as one already published by him, with some modifications.

Four hundred and twentieth meeting.

November 14, 1855. — STATED MEETING.

The PRESIDENT in the chair.

The following gentlemen were elected Fellows of the Academy, viz.: —

John C. Gray, of Boston, Professor James Russell Lowell, of Cambridge, Professor Francis J. Child, of Cambridge, and Richard Greenough, of Boston, in the Section of Literature and Fine Arts.

Rev. William A. Stearns, D. D., of Amherst, in the Section of Philosophy and Jurisprudence.

Professor Albert N. Arnold, of Newton, in the Section of Philology and Archæology.

The following, nominated by the Council, were elected Foreign Honorary Members, viz.: —

Dr. Fr. W. A. Argelander, of Bonn, in the Section of Astronomy.

Victor Regnault, of Paris, in the Section of Physics and Chemistry.

L. D. Vicat, of Paris, in the Section of Technology and Engineering.

Richard Owen, of London, in the Section of Zoölogy and Physiology.

Sir Benjamin Brodie, of London, and P. Rayer, of Paris, in the Section of Medicine and Surgery.

Archbishop Whately, of Dublin, and Victor Cousin, of Paris, in the Section of Philosophy and Jurisprudence.

Franz Bopp, of Berlin, and Friedrich von Thiersch, of Munich, in the Section of Philology and Archæology.

François Guizot, of Paris, in the Section of Political Economy and History.

Professor Gray laid before the meeting a bronze medal commemorating the three eminent botanists, Bernard, Antoine Laurent, and the late Adrien de Jussieu: presented by the Jussieu family.

Professor Joseph Lovering asked the attention of the Academy to the following remarks on motions of rotation.

"Since the time of Foucault's celebrated experiment for illustrating the rotation of the earth by the stability of the plane of oscillation, increased attention has been given to the law of *inertia* as determining the stability of *planes* of motion. The planes of *rotation* conform to this general rule of stability. Astronomy furnishes the only examples of perfectly free rotating bodies: and astronomy, here, as elsewhere, must be invoked, whenever it is required to give an exact experimental illustration of the fundamental laws of mechanics. Artificial experiments realize but imperfectly this perfect freedom of the spinning earth and other planets. Besides the top and the *devil-on-two-sticks*, in which 'philosophy in sport has been made science in earnest,' there are Bohnenberger's less familiar apparatus, first described in 1817,* and Johnston's Rotascope.† The necessity has recently been shown of adding to the description of the former the new *condition* of placing the axis of the apparatus parallel to the earth's axis to avoid the disturbance of the earth's rotation, and the new *application* of the instrument, when otherwise placed, to detecting this rotation.‡

"In 1853, Plücker published an account of Fessel's apparatus for experiments on the laws of rotation;§ and in 1854, Magnus presented to the public an account of his *Polytrop*, also designed for similar illustrations.‖

"1. Plücker preludes his description of the Fessel machine with some remarks on Poisson's mathematical investigations on the subject of rotations,¶ and alludes to Poinset's successful attempt to make the motions generally hidden under the veil of mathematical analysis more sensible to the imagination and the eye.** Poinset thinks that, if many new truths are contained in analysis, they are buried in it for all but a few gifted minds. 'Thus our true method is but this happy mixture of analysis and synthesis, where calculation is employed only as an instrument, a precious instrument, and necessary without doubt, because it assures and facilitates our progress; but which has of itself no peculiar virtue; which does not direct the mind, but which the mind must direct like any other instrument.'

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* Ann. Gilbert, LX. p. 65.

† Silliman's Journal, XXI. p. 265.

‡ Ann. Pogg., XC. pp. 350, 351.

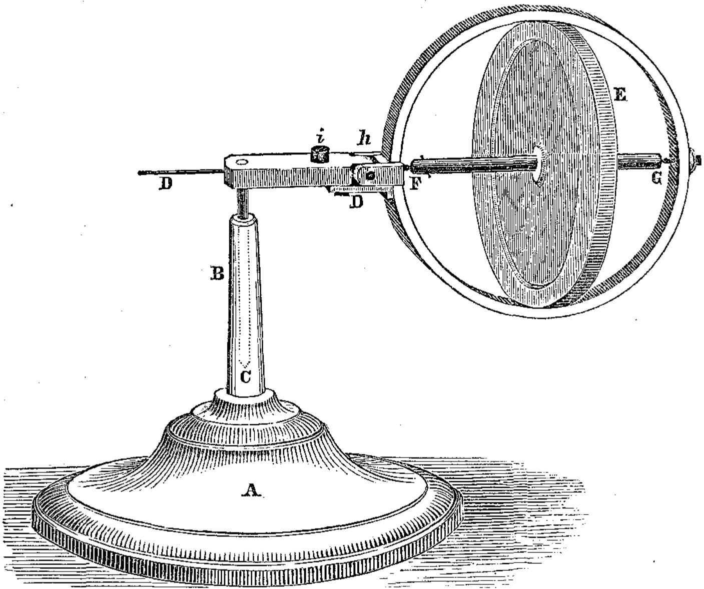
§ Ann. Pogg., XC. p. 174.

‖ Ann. Pogg., XCI. p. 298.

¶ Journ. de Polytechn. Ecole, XVI. p. 247.

** Elemens de Statique, 8th edition, 1842.

"The origin of Fessel's machine was as follows. About 1851 this skilful artist of Cologne, who a few years before had distinguished himself by his beautiful *Wave-machine*, particularly adapted for illustrating the mechanical laws of light, was examining the wheel of a model steam-engine, and observed that, while rolling it on his hand, the horizontal axis did not require to be supported at both ends, while there was a tendency in the axis to move in a horizontal plane. Fessel's practical skill, aided by the suggestions of the eminent physicist Plücker, resulted in the construction of the following apparatus.



The wood-cut represents the apparatus, not exactly as figured in the Annalen of Poggendorf, but as constructed by Luhme, and now exhibited. It is about half the size of the model. Upon a heavy base, A, stands a hollow brass column, B, inside of which turns a steel pin, C, terminating at the lower end in a point. At right angles to this pin are fastened the metallic arms D D. On one of these arms, and at the distance of two inches from the pin, is fastened a vertical ring. Inside of this ring is placed a metallic disc, E, loaded at the edge; and which turns, independently of the ring, upon the axis F G. The motion is communicated by a thread wound upon the axis of the disc. At *h* is a hinge, working on a horizontal point, which allows the ring containing the disc to move in its own plane. This motion can, however, be prevented by a revolving slide underneath. In some experiments the slide is placed so as to prevent the motion on the hinge, and the arms are balanced upon a fixed and pointed rod which is pushed into the brass column. For this purpose there is a little cap under *i*, and a counterpoise which slides on the opposite arm to balance the disc. The top has less friction than Bohnenberger's or Fessel's apparatus. Also in Fessel's machine the disturbing force is the whole weight of the disc and ring, and not, as in Bohnenberger's machine, simply an excess of weight on one side of the rotating body. Hence the precession is more rapid in the first than in the last.

"If the disc is not rotating, it naturally drops down upon the hinge *h*, from its own weight.

"But when the disc is made to rotate rapidly by means of the thread, and then left free, it seems indifferent to gravity, and, instead of dropping, it begins to revolve about the vertical axis. So that the axis of the disc acquires a motion similar to the *Precession of the Equinoxes* in Astronomy. The motion of revolution is opposite in direction to the rotation of the disc. When one of these motions is the greatest, the other is the least. If the motion of revolution is increased artificially, the disc appears lighter. If this motion is retarded, the disc appears heavier. Reciprocally, if the gravity of the disc is artificially increased, the motion of revolution is greater. If the gravity of the disc is artificially diminished, the motion of revolution is less. This variation in the gravity of the disc is easily effected upon an iron disc by means of a magnet. If the action of gravity is prevented by the slide which confines the hinge, there is no motion round the horizontal axis.

"The following popular explanation is given of these peculiarities of motion.* Place the disc in a vertical plane and make it rotate. The tangential motion of each particle has a horizontal and vertical component. As soon as the disc begins from its weight to incline from its original vertical position, the horizontal components still remain parallel to the new position, but the vertical components do not. If the upright edge of the disc nearest to the eye is ascending, this edge is pushed to the left and the opposite edge to the right. These two forces, resulting out of the deviation of the original vertical components from parallelism with the disc, act as through a bent lever to turn the whole disc round a vertical axis in a direction opposite to its rotation. This can be shown experimentally by pressing with the fingers upon these two parts of the edge. As soon as the motion round the vertical axis begins, the horizontal components of the original rotation no longer retain their parallelism with the disc. But the tendency to preserve this parallelism, in other words, the tendency of the disc to preserve unchanged its plane of rotation, generates forces which act on the top of the wheel to the left and on the bottom of the wheel to the right. These forces, acting by leverage, tend to lift the wheel, as may be seen by pressing in the same way with the fingers. When friction is excluded, this uplifting force is an exact balance of gravity, and the wheel neither rises nor falls.

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* Ann. Pogg., XC. p. 348.

"The results of these experiments are remarkable, as showing how differently gravity acts upon a body at rest and upon the same body in motion. When it acts upon a body at rest, it tends to give it a motion round a horizontal axis, but not about a vertical axis. When a body is rotating in a vertical plane, gravity tends to give it no descending motion round a horizontal axis, but simply to turn it upon a vertical line. This apparent mechanical paradox is beautifully illustrated in the *Precession* of the Equinoxes. The disturbing influence of the sun and moon, which represent the gravity to be considered in this astronomical example, would make the equator drop down into coincidence with the ecliptic, if the earth were not spinning on its axis, and would make the precession an unknown phenomenon. But the same forces, acting upon the rotating earth, move the line of equinoxes backward, and leave the obliquity essentially unchanged. It follows, from the experimental illustration, as well as fromthe mathematical theory, that, if the disturbing forces were greater, the precession would be greater; and if the earth's rotation were diminished, *cæteris paribus*, the precession would be increased.

"2. The *Polytrop* of Magnus consists of two rotating vertical discs, arranged upon an axle, as the two wheels of a carriage. These discs can be set in motion by cords wound upon the hub of each disc, the free ends of the cords being attached to the same handle. The axle which carries the discs is movable at its centre around a vertical and also a horizontal axis, but either of these motions can be prevented at pleasure. If both discs are made to rotate in the *same* direction, or if only one disc rotates, it is not easy to turn the whole apparatus on its horizontal axis. But if the machine is prevented from moving round a vertical axis, there is no difficulty in disturbing it around its horizontal axis.

"Thus it appears in this experiment, as well as in those made with the Bohnenberger and Fessel machines, that a force acting upon a free body is prevented from producing motion in *its own direction* by the conical motion which exists around a rectangular axis. The same experiments can be made with the Bohnenberger apparatus, by holding or releasing the middle ring. In mechanics, a body has lost its stability of rotation when it has lost its freedom: and the most complete stability is consistent with perfect freedom. Astronomy hangs up for ever in the sky a splendid illustration of this principle. It cannot be that a less noble law prevails in the kingdom of mind than in that of matter. When the two discs are made to rotate in opposite directions with the same velocity, there is no stability, even when the apparatus is most free. For the tendency of the two rotations when combined with a foreign disturbance being to produce equal and opposite conical motions, the result is the same want of stability as if there was no conical motion in either direction." *

Professor Felton made a short communication on the Pnyx and Bema, at Athens. He remarked that Greek topography is to a great extent a restored science, indebted for its present form and precision to the labors of modern scholars, and to none so much as to Colonel William Martin Leake. A map was exhibited, on which the physical features of Athens were delineated, and the sites of the principal antiquities indicated. Another map was also shown, exhibiting the hill of the Pnyx, with the Bema, carefully drawn according to their exact measurements. The meaning of the names was explained, and it was remarked, that, if these objects are what they are now generally supposed to be, the spot is not only one of the most interesting in Athens, but in the world. The references in the ancient writers were then reviewed in the following order: — 1. Thucydides, B. C. 471. 2. Aristophanes, 444, in several plays, — the Acharnians, Ecclesiazousæ, Knights.

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* Ann. Pogg., LXXXVIII.

3. Plato, 429, in Critias, descriptive of a former imaginary condition of Athens. 4. Æschines, 389. 5. Demosthenes, 385. It was remarked, that, during the Macedonian and Roman periods, the Pnyx was not used, and is only mentioned incidentally, or by way of allusion. 6. Plutarch, A. D. 40, in the Life of Theseus and Life of Themistocles, an anecdote of the Thirty Tyrants. 7. Lucian, 120, in the Fishers. 8. Julius Pollux, 183. 9. Timæus, 3d century A. D., in Lex. Plat. 10. Hesychius, 380. 11. Proclus, 412, Commentary on Plato. 12. Souidas, in the eleventh century. Then came the Crusaders, and the periods of the Dukes of Athens, and of the Turkish domination, during which the knowledge of Athenian topography almost disappeared.

The opinions of the early modern travellers were mentioned. In the seventeenth century, Spon thought it was the Areiopagos: Wheeler, the Areiopagos or Odeion. In the eighteenth century, Stuart and Revett believed it to be the Theatre of Regilla. Chandler, 1765, expressed the opinion that the structure was the Pnyx, or place of the popular assemblies of the ancient Athenians, and from that day to a recent period no doubt has been entertained that the levelled space, supported below by a heavy polygonal wall, was the Pnyx, and that the stone platform was the Bema, or stand on which the orators took their place when they addressed the people.

In 1836, the University of Athens was founded, and Professor Ulrichs, one of the German scholars appointed to a chair in the institution, began to entertain doubts of the correctness of the received opinion. In 1842, Professor Welcker of Bonn, one of the most eminent scholars of Europe, visited Athens, and, in company with Ulrichs, went up to the Pnyx. On examining the place, he found reason to coincide with the impressions of Ulrichs. Since that time he has carefully studied the subject, and in 1852 published in the *Abhandlungen der Königlichen Academie der Wissenschaften* of Berlin a very elaborate dissertation, in which he embodies the results of his studies, and arrives at the conclusion that the Bema is an ancient altar to Zeus Hypsistos, or Jupiter the Highest, and that the levelled space, with the old supporting wall, is the ancient *Pelasgicon.* This essay was answered by Professor Ross, formerly of Athens, now of Halle, in a pamphlet, published in 1853. Welcker replied by another pamphlet in 1854.

Professor Felton gave a summary of the arguments on both sides, and stated that the subject had occupied much of his attention while in Athens; — that he had come to the conclusion that the received opinion is correct; — and, in confirmation of this view, went at some length into an examination of the authorities, especially Plato, Demosthenes, Plutarch, and Proclus, citing a passage from the last-mentioned author which had never been considered before, and which was pronounced to be almost, of itself, conclusive: and quite conclusive, as the last term in a cumulative argument, the expressions being precisely applicable to the shape of the supposed Pnyx, and to no other place or structure in Athens.

Four hundred and twenty-first meeting.

December 11, 1855. — ADJOURNED QUARTERLY MEETING.

The PRESIDENT in the chair.

The following gentlemen were elected Associate Fellows; viz.: —

Rev. Moses A. Curtis of South Carolina, and Professor Charles W. Short, M. D., of Louisville, Ky., in the Section of Botany.

Drs. J. P. Kirtland, of Cleveland, Ohio, and J. C. Dalton, Jr., of New York, in the Section of Zoölogy and Physiology.

Professor Dennis H. Mahan, of West Point, in the Section of Technology and Engineering.

Hiram Powers, Thomas Crawford, William C. Bryant, and Washington Irving, in the Section of Literature and the Fine Arts.

Professor W. B. Rogers exhibited to the Academy a set of Schönbein's test-papers for ascertaining the amount of ozone in the atmosphere, and explained their use and the great importance of the observations based upon them.

Professor Rogers also exhibited a series of diagrams explanatory of certain conditions of binocular combination not hitherto described, and intended especially to demonstrate *the form of the curve which results from the binocular union of a straight line with a circular arc, or of two equal circular arcs with one another.*

"First. Of the binocular resultant of a *straight line* and a *circular arc.*

"Assuming the optical centres of the two eyes as fixed during the act of combination, the centre of the eye directed to the circular arc may be regarded as the vertex of a cone whose surface includes all the positions of the optical axis of that eye as successively directed to the different points of the arc. This cone will of course be right or oblique, according to the direction in relation to the plane of the paper of the line joining the optical centre with the centre of the circle of which the arc is a part. The axis of the other eye, in ranging from end to end of the vertical line, vibrates in a plane which during the binocular combination intersects the conical surface in an attitude depending on the distance between the optical centres, the place of the diagrams, and the relative position of the component lines.

"The two optical axes, directed each moment to corresponding points of the vertical line and arc, meet in the conical surface, forming optically a series of resultant points which together compose the binocular resultant curve. *This curve must, therefore, be a conic section,* the nature of which will depend on the direction of the cutting plane in reference to the conical surface.

"Considering the several cases in which the arc is convex towards the right line or concave towards it, and in which the combination is effected before or behind the plane of the diagram, all the results may be thus summed up.

"(*a.*) When the arc is convex to the right line and they are united beyond the plane of the diagram, or when the arc is concave to the line and they are combined in front of it, the binocular resultant may be either an ellipse, a parabola, or an hyperbola; but in either case it will turn its convexity obliquely towards the observer.

"(*b.*) When the arc is concave to the right line and they are united beyond the plane of the diagram, or when it is convex to the line and they are combined in front of the diagram, the binocular resultant is always an arc of an ellipse turning its convexity obliquely away from the observer.

" Second. Of the binocular resultant of *two circular arcs.*

" In this, as in the preceding combinations, the optical centres are to be regarded as immovable during the experiment. Each eye, while viewing the successive points of the arc presented to it, revolves in such manner as to carry the optical axis around in a conical surface. Thus two conical surfaces are generated, having for their respective apices the centres of the two eyes, and including all the directions which the optical axes assume in combining the successive pairs of corresponding points of the circular arcs. In general terms, therefore, *the binocular resultant in all such cases may be described as the curve line in which the surfaces of the two visual cones intersect one another.*

" It is only, however, under special conditions that the resultant thus formed is a *plane curve.* When the circular arcs presented to the two eyes are of unequal curvature, the visual cones by their intersection produce a curve which cannot be included in a plane, but lies in an inflected surface; and this accordingly is the form which the resultant takes whenever circular arcs of unlike curvature are combined either with or without a stereoscope.

" The several effects of the binocular union of circular arcs of equal length and curvature may be thus summed up.

" (*a.*) When the arcs are convex to one another, and are combined behind the plane of the components, or when they are concave to one another and combined in front of this plane, the resultant may be either an hyperbola, a parabola, or an ellipse; but in either case it will be convex towards the observer and in a vertical plane.

" (*b.*) When the arcs are concave to one another, and are combined behind the plane of the components, or when they are convex to one another and combined in front of this plane, the resultant is always an arc of an ellipse concave towards the observer and in a vertical plane.

" Whenever, in any of the combinations referred to, the resultant curve takes the position of the *sub-contrary section* of the cone, it of course becomes an *arc of a circle.*"

Professor C. C. Felton exhibited to the meeting a series of silver coins of Athens, which he had lately received from Mr. George Finlay, of Athens, and made some remarks, of which the following is the substance.

"Mr. Finlay is the distinguished historian of the Byzantine Empire. He has resided in Athens for many years, occupied with historical studies and archæological researches. The ancient coins of Greece, and the coins of the Byzantine Empire, of which he has a large and valuable collection, have been much attended to by him, both on account of their intrinsic interest and for the illustrations they afford of numerous points in history.

"The excellence of the Athenian currency has been often the theme of eulogy. The practical sense of the Athenian people was as remarkable as their genius for literature and art. We are apt to forget, in our admiration of the Parthenon adorned by the sculptures of Pheidias, and of the tragedies of Sophocles and the orations of Demosthenes, that the same people were equally eminent in commerce, manufactures, and agriculture; that they had devised a judicious system of public revenue, and well understood the theory and practice of credit in commercial and banking operations. At an early period, the silver coinage of Athens acquired a general currency throughout the commercial world. So well did the Athenians perceive the advantage of this, that they retained, even during the periods of the highest excellence in the fine arts, much of the rudeness of the earliest mintage: so that the coins of Macedonia, and of many of the colonial states, far surpassed, in beauty of design and execution, the coins of Athens. This adherence to the archaic style was intentional; it was the result of practical wisdom, abstaining from change, in order not to affect the established credit of the ancient currency.

"The principal authorities on ancient coins are Spanheim, Eckhel, Mionnet, Boeckh, Hussey, Cardwell, and Humphrey; together with the lists of the coins in the public and private collections of Europe.

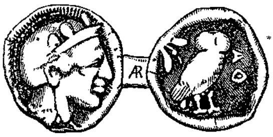
"The silver coins now exhibited are,—1. *Τετράδραχμον.* 2. *Δραχμή.* 3. *Τριόβολον.* 4. *Ὄβολος.* 5. *Τριτημόριον.* 6. *Ἡμιοβόλιον.* 7. *Τεταρτημόριον.* These coins have been carefully weighed by Professor Horsford, with the following results:—

	Troy Weight.		French Grammes.
Τετράδραχμον (four drachmas),	255.99 gr.	=	16.5778
Δραχμή (drachma),	63.20		4.0929
Τριόβολον (three-obol piece, or half-drachma),	30.70		1.9883

	Troy Weight.		French Grammes.
Ὄβολος (obol, one sixth of a drachma),	10.50 gr.	=	0.6802
Τριτημόριον (three fourths of an obol),	7.27		0.4711
Ἡμιοβόλιον (half-obol),	3.47		0.2250
Τεταρτημόριον (quarter-obol),	1.50		0.0984

"The weight of the Attic drachma, as deduced from the relations of the Attic silver weights, and from numerous comparisons of existing specimens, has been estimated by Hussey at 66.5 grains; by Boeckh, at 67.4. If we assume 67, which is nearly the average of the two, the weight of the tetradrachmon, usually estimated at 266 gr., will be 268. The tetradrachmon now exhibited has lost, taking the larger estimate, 12.01 gr.; taking the smaller, 10.01 gr., or a little less than five per cent. The drachma has lost 3.80 gr., or about six per cent. The triobolon has lost 2.80 gr., or nearly nine per cent, and so on; the smaller the coin, the greater generally being the loss. But in all cases the loss is surprisingly small, the difference between this tetradrachmon and the standard weight being a less percentage than that between some American dollars of different dates. Cardwell states that, of twelve drachmas described in the Hunterian Catalogue, the heaviest weighs 66¼ gr., and only one weighs less than 60. Of the tetradrachma, of which the Catalogue enumerates one hundred and two, seventy range over a difference from the standard weight of not more than 10 gr., assuming the standard weight to be 266 gr., or 12, assuming it to be 268 gr. Of fourteen tetradrachma in the British Museum, the heaviest weighs 264 gr.

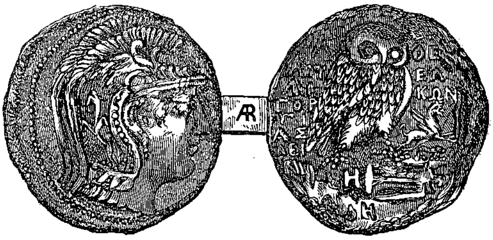
"The drachma now exhibited is evidently very old, — probably belonging to the sixth or the early part of the fifth century B. C. On the obverse is the head of Athena (Minerva), in the Æginetan style; on the reverse, the owl, with the olive-branch at the left and the legend Α Θ on the right. The following is an exact copy.



"The figures on the smaller coins are traceable, though some of them are much worn.

"The tetradrachmon has on the obverse the head of Athena helmeted and crested. On the reverse, the owl standing upon a diota, on which is the letter Η, and under it another Η. The legend is

Α Θ Ε, the first letter being on the left of the head of the owl, and the other two on the right. Below are names of three persons, probably magistrates. The first is ΑΠΕΛΛΙΚΩΝ, occupying two lines, partly on one side and partly on the other of the owl. The next, inscribed on the left of the owl, is ΓΟΡΓΙΑΣ, in three lines. And the third, which could be made out only by a careful examination, under different lights, is ΔΕΙΝΙΑΣ, the first two syllables being on the left in two lines, and the third on the right of the owl. On the right of the owl, in the space between the syllables ΚΩΝ and ΑΣ, there is a winged Pegasus, leaping. The three names are, then, Apellicon, Gorgias, and Deinias. The following figure represents the coin very faithfully.



"Eckhel (II. 219, 220) describes two coins of the time of Mithridates VI., the first of which has the names of *Mithridates* and *Aristion*, the second has *Aristion* and *Philon*, with three letters of a third, ΗΓΙ; to these he subjoins a third, with the names *Apellicon*, *Gorgias*, and part of a third name, *Diosio*. Of the date of the first two there can be no doubt; whether the third is synchronous with them depends upon the identity of the Apellicon with the person bearing that name in the second. It seems highly probable that the tetradrachmon now exhibited belongs to the same period as the last of those described by Eckhel, in the passage referred to, since two of the names are the same on both.

"The winged horse is common on the coins of Mithridates, and the political connection between that monarch and the tyrant Aristion explains the introduction of the name of Aristion on a coin of the King of Pontus, and of his symbol on an Athenian coin struck by Aristion. Aristion was a Peripatetic philosopher, who, having taught in various places, was sent on a mission to Mithridates, and afterwards became tyrant of Athens. Sulla laid siege to Athens in B. C. 87. Aristion set fire to the Odeion and fled for refuge to the Acropolis; but the Acropolis having been taken, Aristion was dragged from the altar of

Athena and put to death. Apellicon was also a teacher of philosophy and a book collector, and, like some modern collectors, could not resist the temptation of stealing books, when he was unable to come honestly by them. He was obliged to flee from Athens, but returned during the tyranny of Aristion. He died just before the siege of Athens by Sulla, and his library was seized by the right of conquest (another form of stealing), and carried by the conqueror to Rome. He is noted in literary history for the possession of an autograph copy of Aristotle's works, which he procured in Asia Minor, and afterwards edited. Apellicon may be placed about 80 B. C.

"There was an Athenian Gorgias, one of the teachers of Cicero the Younger, and mentioned by him in a letter to the accomplished freedman Tiro. Cicero *père* had ordered the young man to dismiss Gorgias, on account of his questionable morals. Whether the Gorgias of the tetradrachmon is the same person, cannot be determined. He may have been of the same family, since young Cicero was in Athens about 44 B. C. He (Cicero the Younger) writes thus, after giving an account of his studious occupations: 'De Gorgia autem, quod mihi scribis, erat quidem ille in quotidiana declamatione utilis; sed omnia postposui, dummodo preceptis patris parerem. Διαῤῥήδην enim scripserat, ut eum dimitterem statim.' (Ad. Div. Lib. XVI. 21.)

"This incident shows that the name of Gorgias was not unknown at Athens, about the period to which the coin is referred. The teacher of Cicero may have been the son of the colleague of Apellicon. I find no Deinias of this period. He probably had something to do with the mint, and has left no other record of his name.

"Besides the valuable and interesting coins above described, I have, from the same accomplished scholar, a series of about eighty copper and bronze coins, embracing the common copper coins of Athens, several colonial pieces of Greek cities, with portraits of Roman emperors, seven imperial coins, with very characteristic portraits, belonging to the first three centuries; a series of coins of the Eastern Empire, commencing with Justin I. A. D. 518 – 527, and ending with Isaac II. Angelos, A. D. 1185 – 1195, the last emperor but three before the conquest of Constantinople by the Latins; and a series of six silver coins, among which are one of a Prince of Achaia, one of Manuel of Trebizond, 1238 – 1263, and a very rare silver coin of the Duke of Athens. All these are valuable in an historical point of view. During the Middle Ages, the Byzantine empire supplied the currency of Western

Europe, and her gold pieces are known in Western literature as Bezants, or Byzants. Mr. Finlay is the only writer who has set forth the financial, political, and literary history of Byzantium in its true light and its real importance.

"It is proposed here, however, to consider only the Attic copper coins, in addition to the silver pieces. They are, — 1. The Chalcus (χαλκοῦς) and duplicate. 2. Half-Chalcus. 3. Two-Lepta piece. 4. The Lepton, the smallest product of the Attic coinage. Now, as there were seven lepta in a chalcus, and eight chalcoi in an obolos, we can conveniently construct a table of the values of the Attic currency, in our own money, by taking these and the preceding data, comparing the weight of the silver pieces with our own standard dollar, and making an allowance for the difference of alloy, which was much smaller in the ancient mint than in our own.

"Assuming the weight of the drachma, as above determined, to be 67 gr., and the per cent of alloy to be the same as in the American dollar, the drachma will be worth 16.26 cents. Adding a small percentage for difference of alloy, and we have, almost exactly, the sixth part of a dollar, or 16.66 cents, for the value of the Attic drachma. As the drachma is the unit to which the rest of the series bear a definite proportion, we may construct the table as follows, beginning with the smallest copper coin: —

1 Lepton = $0.0004 or $\frac{4}{10}$ of a mill.
7 Lepta = 1 Chalcus = 0.0034 or $3\frac{4}{10}$ mills.
8 Chalcoi = 1 Obolos = 0.0277 or 2 cents $7\frac{7}{10}$ mills.
6 Oboloi = 1 Drachma = 0.1666 or 16 cents $6\frac{6}{10}$ mills.
100 Drachmai = 1 Mna = 16.666 or 16 dollars 16 cents $6\frac{6}{10}$ mills.
60 Mnai = 1 Talanton (Talent) = $1,000, or one thousand dollars.

"The tetradrachmon exhibited above is worth, according to the same rule of estimation, 63 cents $6\frac{1}{2}$ mills; it has therefore lost a little less than three cents. The drachma is worth 15 cents 7 mills; it has lost 1 cent $9\frac{1}{2}$ mills, — a larger rate of loss than that of the tetradrachmon, which would have been, according to this proportion, 7 cents 8 mills. But the problem of settling the comparative value of money in different ages, in reference to daily life, is another, wholly different, and much more difficult question, if indeed it can be settled at all. The comparative value of money changes with every moment of time, and every degree of latitude and longitude. If we take the price of wheat as a standard of comparison, even that is equally fluctuating; the state of the market being affected by many influences, some permanent and regular, others casual, and all together making the price of wheat, or any other article of daily consumption, or the wages of labor, just as uncertain as the worth of money itself. This subject requires a more careful investigation than it has yet received."

Four hundred and twenty-second meeting.

January 8, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Dr. John C. Dalton, Jr., Rev. Dr. M. C. Curtis, and Dr. C. W. Short, accepting their appointment as Associate Fellows.

Dr. A. A. Gould exhibited some engraved stones found in the vicinity of Beyrout, bearing Phœnician characters, and purporting to be of great antiquity.

Professor Lovering exhibited a specimen of copal containing lizards, belonging to Captain Bertram, of Salem.

Professor W. B. Rogers, referring to the ozonometer exhibited by him at the last meeting, stated that he had recently been testing it; and had observed, during the great snow-storm of January 6th, that the quantity of ozone in the atmosphere was very great. At the time of the present meeting there was scarcely any.

Professor Rogers also gave an account of an experiment of allowing the water from a Cochituate pipe to flow with full force into a glass globe, having an outlet the axis of which was at right angles to that of the orifice by which it entered. After a short time, the water in the globe took on a rotatory motion about the axis of the outlet, and a column of air was seen to enter from the outlet in the centre of the stream of water, and extend more or less deeply into the globe in proportion to the force with which the water was allowed to enter. When the experiment was tried with a globe with two outlets, at opposite sides, the air column passed quite through it, and the water escaped as a hollow expanding cylinder at each orifice.

Four hundred and twenty-fourth meeting.

February 12, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary announced the receipt of letters from Guizot, Vicat, Richard Owen, and Sir Benjamin Brodie, accepting the Foreign Honorary Membership of the Academy.

Professor Agassiz addressed the Academy at length on the subject of Classification in Zoölogy. The divisions of the Animal Kingdom, he said, are natural, not artificial. They are based upon ideas emanating from the Author of nature. So far as the systems of naturalists have been in accordance with these ideas, they are true, but not their own; so far as they have been at variance with them, they have been their own, but are artificial, and not true. Professor Agassiz proceeded to remark upon Cuvier's system of classification, and the ideas on which it was based, characterizing it as, in the main, in accordance with the plan of creation. He dwelt particularly upon the class of Reptiles, and spoke of the divisions which different naturalists had made in it. He defined the ideas which are the basis of the division into families and orders. He showed on embryological grounds that the separation of Turtles as a class (proposed by Strauss) was unnatural. He had observed distinct characters of superiority and inferiority among them, which he had adopted as the basis of a division into sub-orders, by which he was enabled to classify the species under a natural arrangement, corresponding to the families adopted by Duméril and Bibron, but which are not true families. Professor Agassiz illustrated his remarks with colored drawings, intended for publication in the forthcoming volume of his Contributions to American Natural History.

Dr. A. A. Hayes exhibited an ingot bar of pure Aluminium, lately received from Paris, obtained by the method and under the eye of M. Deville, who has so largely contributed to science and the arts, by producing this metal in masses. A brief description of its physical characters, including its sonorousness *per se*, as commented on by M. Dumas, was given; and Dr. Hayes added, that his own observations had led him to conclude that this metal has a large capacity for heat, rising in temperature slowly, and losing its excess gradually. Generally, its mechanical characters may be compared with those of alloyed or standard silver, while in chemical relations it differs remarkably, by approaching more closely to those of the noble metals. A perfectly pure sample, many times heated and cooled, had its surface only slightly changed; while fragments long exposed to the temperature of melting silver did not melt and coalesce. This effect is noticeable in pure gold-filings also, and may arise from molecular changes, induced by the absorption, *without combination*, of oxygen; as it is not observed under suitable fluxes. This metal alloys readily with other metals, and can be easily transferred from the positive to the metal negative of a galvanic series, in the mode of electro-plating. When condensed by hammering, or laminating, it loses its white color in part, acquiring a leaden hue; the white color can be restored by producing the "mat" surface of the silversmith. M. Deville's process for obtaining the metal is founded on the substitution of sodium for the aluminium of the chloride of aluminium, in a state of vapor, and the subsequent fusion of the aluminium, under a flux of chloride of sodium and aluminium. In M. Deville's hands, the process for sodium, as a first step in the production of aluminium, has become one of the most beautiful and effective known in chemistry. A mixture of equal equivalents of carbonate of lime and carbonate of soda is heated in an appropriate vessel, with just so much carbon as will form carbonic oxide with the oxygen present, and the sodium is distilled off from the mass, not only pure, but often continuously.

In reply to a question by the President, Dr. Hayes stated that this had been called a *new metal* erroneously. It has long been known to chemists, and seven years since suspicions were entertained that its characters had been imperfectly observed, and that it might prove a malleable metal. These suspicions have been more than confirmed, and a metal of high value has been given to the arts.

The importance of the labors of M. Deville is more apparent when considered in connection with general chemistry. Aluminium, before his researches were commenced, was known to us as a spongy, gray metal, which in a heated state attracted oxygen and returned to its earthy condition. Certain characters made up its description, and these presented little attraction, as they promised no useful application. So soon as the genius of Deville enabled him to throw the clear light of experimental results on this subject, chemists saw that he had not only rendered more sure what was known, but had created as it were *a new assemblage of characters to be included under the term aluminium.* Nor was this all; he has added another to the class of bodies represented by carbon, which, in different physical states, possess distinct chemical relations.

The consideration of this relation of physical state, or condition, to chemical action, as a study, has been much advanced by the discoveries of M. Deville; and so beautiful is the illustration, that the field of research thus newly opened through his means is attracting, and will continue to engage, the highest efforts of the best-disciplined minds in its enlargement.

In reply to the question of price, as affecting economical application, Dr. Hayes remarked that it was unsafe to limit the diminution of price in a chemical product, especially where the material of manufacture is abundant. The first iodine he used cost at the rate of forty dollars per ounce; it has been as low as seventeen cents for the same quantity, and yet the sources are by no means common. Phosphorus was in common use at sixteen dollars per pound, and when the price declined to eight dollars, stocks were secured in expectation of increased price, which at present is about seventy cents. Sodium, in consequence of M. Deville's experiments, is now abundant at a low price, and the list might be extended; proving that, when demand arises for any product like aluminium, the cost of production can be surprisingly reduced. As the metal has many special applications, hardly a doubt exists of its extended consumption.

Dr. A. A. Gould referred to the loss which the Academy had sustained in the recent decease of Dr. Thaddeus William Harris, and offered the following resolutions: —

" *Resolved,* That the Fellows of the Academy deeply deplore the recent decease of Dr. Thaddeus William Harris, one of the older and most distinguished of their number, and would mingle their sympathies in the sorrow of his bereaved family.

" *Resolved,* That as a bibliographer and an archæologist, in relation especially to the history of our own country, he held a distinguished rank; that as a naturalist he has not been surpassed by any of his countrymen, and has exhibited a patience, thoroughness, and accuracy of observation in the various departments of Natural History, a truthfulness in the delineations both of his pencil and his pen, and a singular facility in employing language intelligible to the common reader and at the same time fulfilling all the requirements of science, which render him a model for the interrogator of Nature; and that, through a long life of untiring industry, he has accumulated and published a mass of original observations, of an eminently practical bearing, which have won for him high consideration both at home and abroad, and will constitute for him an enduring monument.

" *Resolved,* That while both the scientific and the practical world are largely indebted to him for his published papers, it is to be regretted that very many others of equal importance, which are known to have been prepared, or are in process of preparation, remain unpublished; and that the Academy tenders its assistance in their publication.

" *Resolved,* That in view of his unobtrusive and virtuous life, and the eminent though unclaimed distinction due him as a man of science and letters, a committee be appointed to prepare a Memoir of his Life and Labors, to be published by the Academy."

The resolutions were seconded by Professor Agassiz, who added, that Dr. Harris had had few equals, even if the past were included in the comparison; and they were adopted unanimously.

In accordance with the last resolution, Dr. A. A. Gould was chosen a committee to prepare a Memoir of the Life and Labors of Dr. Harris for publication by the Academy.

Four hundred and twenty-fifth meeting.

March 11, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Lovering exhibited *L'Appareil Régulateur de la Lumière Electrique,* as contrived and constructed by M. J. Duboscq, of Paris, and presented the following translation of his description of the mechanism: —

"If two metallic wires are attached to the two poles of an energetic voltaic battery, and the free ends of these wires terminate in thin rods of compact carbon from gas retorts or of graphite, at the moment when the two carbon rods touch, a vivid spark is seen to play between the nearest points. If the two rods remain in contact, they grow warm gradually up even to a red heat; next, a part of the carbon is inflamed, burns, and disappears; another portion seems to be volatilized, and little by little the two extremities of the carbon rods, which touched one another, separate more and more, from waste of material, without on this account any cessation of the current circulating in the pile, the wires, and the carbon rods. The part of the rods which has disappeared is found to be replaced by a luminous purple jet, in which incessantly whirls an incandescent vapor of carbonized particles, which the negative pole seems to abstract from the positive pole, or which the latter projects towards the former. The distance between the carbon points has a limit, depending on the intensity of the current, beyond which the purple light is extinguished, the incandescent jet ceases, and the current is interrupted. In a vacuum this distance is much greater than in air, since the electricity, not having the atmospheric pressure to overcome, darts from the carbon even before the points have arrived at contact. But the carbon, which is volatilized and condensed upon the sides of the *re-*

ceiver which contains the rods, interferes with the ease of the experiment in void spaces. It is necessary, therefore, to be content with the length of arc which can be obtained in common air, and to seek only to regulate as far as possible the consumption of carbon, and the distance at which the extremities of the rods must be held in order that the luminous arc produced shall have its *maximum* intensity. The first contrivances for attaining this end were not successful. The carbon rods were pushed together by the hand in proportion as they diminished in length; but they received not the necessary regularity or proportional quantity of motion. Petrie in England and Foucault in France had simultaneously the idea of applying the electrical current itself to regulate the advance of the carbon points, which were to conduct this same current under the form of a luminous jet. The regulator of the electrical light, by Duboscq, rests upon the same principle as the apparatus of the two physicists just named. In the regulator of Duboscq, represented in the wood-cut, an electro-magnet, excited by the action of the electrical current which circulates in the copper thread *q* of the coil B, inside of which is enclosed an iron cone, F, placed in the base of the instrument, attracts into contact a piece of soft iron, K. To this is attached a bent lever, L, which turns at x upon a horizontal axis, and is pressed up by a spring, *s*, and rests at *o* against a short lever, having its axis of rotation horizontal. This small lever carries at *d* a steel nib, the object of which is to check the toothed wheel *r*. This wheel has a fly, and an endless screw, V, to which a movement can be given by a second wheel, *r'*, the pinion of which is in connection with the great toothed wheel *p*. The latter contains the mainspring for moving the machine. This great toothed wheel has two grooves of different diameters, the use of which will soon be indicated, and upon which run the two chains *h*, *h'*, which, after having passed upon the pulleys *p p*, *p' p'*, are

Fig. 1.

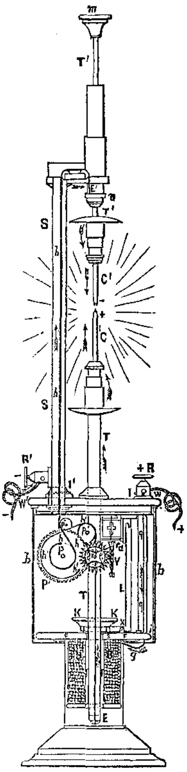
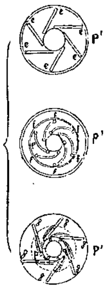


Fig. 2.



attached, at E and E′, to two copper tubes, in the prolongation of which, at C and C′, the carbon conductors are fixed. A small lever, movable by hand, carries a second nib similar to that of the small lever, and serves to stop at will the motion of the apparatus. This whole assemblage of parts is shut up in a metallic cover, the upper part of which can be raised in order to display the pieces of the interior mechanism. The following is the march of the current in the regulator when the carbon points touch, or when the luminous arc is not interrupted.

"For this purpose, assume, as most physicists do, that the electrical current advances from the positive to the negative pole, and suppose that the positive pole of Bunsen's carbon battery is in communication with the clamp R, and the negative pole with the clamp R′. The current, entering at R, descends through the wire *q*, which an ivory ring insulates at I and *i* from the brass plate W W′, and from the plate and metallic columns which support the mechanical parts of the apparatus. Running the whole length of the wire *q* of the coil, the current passes into the iron plate F, which constitutes the pole of the electro-magnet. The tube T, which carries the carbon rod C, touches constantly this plate F, and continues the conduction of the current, which, arriving at the place where the carbon points touch, passes from one to the other, traverses the carbon rod C′, ascends its tube T′, descends through the column S, and goes from this column to the clamp R′, which corresponds to the negative pole of the battery. The column S is insulated from the rest of the apparatus by an ivory ring I′, in order that the current, to complete its circuit, may be forced to go through the carbon rods. Things being thus disposed, the carbon points touching, or being removed by the distance best adapted to the most brilliant arch of light, the plate F will be strongly magnetized by the action of the current; the iron K will be drawn into contact; its levers will rest against the toothed wheel *r*, and, even when the spring in the wheel P is wound up, all will remain in equilibrium in the interior of the apparatus. The electricity will continue to pass, wasting the carbon C by the transfer of its molecules to the carbon C′, and both of them by their lively and rapid combustion in the air. After a certain time, the carbon points will be so much separated that the current experiences a considerable resistance in breaking through the intervening space. The intensity of the current being diminished, the spring *s* will destroy the contact of K; its levers will discharge their function; the tooth *d* will quit the wheel *r*; the main-spring will set in motion the wheel P, and the regulating parts r, r', which are attached; the chain h', which moves the carbon-holder of the positive pole, rolling up on the groove of p', will make the carbon C ascend, while the chain h, unrolling from about the groove of p, will make the corresponding carbon C′ descend. The ratio of the diameter of the pulleys p, p' can be changed by a special system of elastic pressures belonging to the groove p of the pulley of the negative pole, and which is represented on a large scale in Figure 2. By the help of a key, any dimension wished is given to the pulley p. This dimension must always be such that the point of contact of the two carbons shall be maintained at the same elevation, in spite of the more rapid waste of the positive pole. Now the quantity by which the negative carbon descends, and that by which the positive carbon mounts, are proportioned to the circumferences of the respective pulleys, and these circumferences are in the same ratio as their diameters. If the positive carbon is wasted three times more rapidly than the negative carbon, the pulley p' must have three times as large a diameter as the pulley p, in order to maintain the point of junction at a constant level. The ratio of the diameter of the two pulleys must be regulated by trial every time the carbons are changed, since a difference in their diameters or their densities may cause a great difference in the waste of the two incandescent extremities. The contact-maker K is provided with a driving-screw, so as to alter at will its distance from the electro-magnet, according to the energy of the pile used, which struggles with more or less force against the spring s, which resists contact. The place at which it is best to stop the contact-maker K is easily discovered by a hissing which is produced when the carbons are too near. This screw is so turned as first to provoke this hissing, and then turned gently in the opposite direction until the noise ceases. The proper place for experiment is where the hissing stops. If within or without this position, the carbons are too near or too distant.

"The tube of the negative carbon is provided at n with a nut or an articulated knee, by which there can be impressed upon it, with the aid of the buttoned stem m, a slight conical movement around the vertical, so as always to make its point coincide exactly with that of the positive carbon. After one or two experiments with this apparatus, the play of its parts presents no longer any serious difficulty, and its manipulation becomes as simple as that of the Carcel lamp, or the ordinary *lampe à moderateur.*"

Professor Lovering asked the attention of the Academy to a discussion which seems to have been going on as early as 1843, and which had been recalled to his notice by a letter which he had recently received from a friend in Cincinnati, who questioned the propriety of including among the questions for the examination of candidates for the High School of that city the following: — "Does the Mississippi River run up hill or down hill?"

"I shall introduce what I have to say upon the subject with an extract from the Common School Journal.* The article from which I make the extract is headed 'Geographical Error.' The writer says: —

"'The following egregious blunder, with the captivating title '*Water running up Hill*,' is going the round of the public papers, to be caught up by thousands of school-teachers, and imprinted upon the minds of tens of thousands of scholars. *Dr. Smith, in a recent lecture on Geology, in New York, mentioned a curious circumstance connected with the Mississippi River. It runs from north to south, and its mouth is actually four miles higher than its source: a result due to the centrifugal motion of the earth. Thirteen miles is the difference between the equatorial and polar radius; and the river, in two thousand miles, has to rise one third of this distance, it being the height of the equator above the pole. If this centrifugal force were not continued, the rivers would flow back, and the ocean would overflow the land.*'

"This statement of Dr. Smith, when separated from the paradoxical declaration with which the newspapers have heralded it, is wholly correct, except in the numerical details, in which Dr. Smith evidently did not aim at great precision. But the writer in the Journal (who is understood to be President Horace Mann) not only attacks the accuracy of these details, but assails the mechanical principlewhich lies at the foundation of Dr. Smith's statement; saying, that 'it would be difficult to compact a greater number of errors of fact and of principle into one short paragraph, than are found in the above quotation.' The precise numbers involved in this question are of secondary importance. I am willing, and Dr. Smith no doubt is willing, that Mr. Mann should have the numbers as he states them. Suppose then that the length of the Mississippi River, *measured on a meridian*, is only fourteen hundred miles, and that the mouth is only about two and a half miles more distant from the earth's centre than the source. The question arises whether the flow of the river from north to south is caused by the centrifugal force, or whether the criticism of Mr. Mann upon this mechanical solution of the problem is sound. The critic asks: 'Why then does not the mighty force which sends the Mississippi *up hill* four miles send the Nile back to the Mountains of the Moon?' And again he asks: 'Why does not the centrifugal motion of the earth drive the waters of the Atlantic and Pacific Oceans towards the equator, at the rate of ninety-six miles a day?'

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* Vol. V. p. 65.

"Let us attend next to Mr. Mann's own explanation of the flow of the Mississippi. After enlarging upon the protuberant matter at the earth's equator, he continues: 'Now water, like every other material thing, is attracted towards the centre of gravity. The centre of gravity is that point about which all the parts are *in equilibrio*. Or, in popular language, water, like everything else, being attracted by matter, is most attracted, other things being equal, by the greatest quantity. The only philosophical idea we can have of *up* or *down* is *from* or *towards* the point of greatest attraction, that is, from or towards the centre of gravity.' Elsewhere, this writer speaks of the earth 'being an oblate spheroid, having the greatest quantity of matter, *and therefore the greatest attraction*, under the equator.' Finally he says: 'The whole truth is, that the waters of the Mississippi are constantly tending to the common centre of attraction; but, being prevented from approaching that centre *in a direct line*, they approach it indirectly, by moving forwards along the bed of the channel. They are constantly approaching the centre of gravity, that is, *they are constantly descending*.'

"One error into which Mr. Mann has fallen is that of supposing that the attraction which the earth exerts at any particular point of its surface is a local phenomenon, and not the resultant of the aggregate attractions of every particle of matter in the earth. This error leads him to a conclusion contradicted by the experiments and observations of the last two centuries; namely, that where there is the most matter, there is also the most attraction, and that consequently the attraction is stronger at the equator than it is at the poles. We might ask Mr. Mann why this mighty force of attraction does not send the

Nile back to the Mountains of the Moon. My own answer is, that this excess of attraction at the equator does not exist, and therefore neither carries the Mississippi towards its mouth, nor tends to carry the Nile back from its mouth. To many, the assumption will seem a plausible one, that the excess of *matter* at the equator should be accompanied with a redundancy of attraction there. They forget that the *whole earth* attracts everywhere. And calculation proves that the attraction of the whole earth upon a body at the surface is greater the nearer this body is to the poles; and for this obvious reason. The excess of equatorial matter operates to the prejudice of equatorial gravity, by keeping the rest of the earth at an unusually large distance. Moreover, it is of no importance to the flow of the Mississippi whether the stronger attraction is at the equator or at the poles; since the flow of water is determined, not by the intensity of the gravity at the place where the water is, or anywhere else, but by the direction of this gravity in relation to the surface at that place.

" Again, Mr. Mann speaks of the centre of gravity of the earth, and says that the waters of the Mississippi are constantly approaching this centre of gravity. But why is it that the Nile moves northward? Does that also approach constantly the same centre of gravity? The whole argument from the centre of gravity of the earth is fallacious. For the earth has no fixed centre of gravity. There is a new centre of gravity to the earth for every new spot of surface which an attracted body visits. Water could not flow in any direction without approaching some of these centres of gravity, and deserting others. And, in fact, the waters at the mouth of the Mississippi are farther from the centre of gravity which belongs to the geographical situation of the mouth, than the waters of the sources of the river are from the centre of gravity which belongs to the position of these sources. In the case of the Nile, exactly the reverse of this is true.

" What, then, is the true mechanical principle which is applicable to these cases? It is this. The mutual attraction of the particles of matter upon each other, which, if undisturbed, would mould a yielding earth into the form of a perfect sphere, have been so modified by the centrifugal force, resulting from the planet's rotation, as to make the figure of an ellipsoid, in which the largest radius exceeds the shortest by thirteen miles, the true figure of equilibrium. Cohesion enables the solid land to hold out to a limited extent against these moulding influences. But the free waters yield readily to their plastic touch, and are at rest only so long as the figure of equilibrium is unruffled, and always move in such a way as to restore it when it is disturbed. Water everywhere flows from places which are above the surface of equilibrium to places which are below it. The mouth of the Mississippi is two and a half miles more distant from the earth's centre of figure than the source. But it ought to be three miles. It is, therefore, below the surface of equilibrium. And the water flows south to fill it up to the proper level. The source of the Nile ought to be about two and a half miles more distant from the earth's centre than the mouth of that river. But the excess of distance is more than two and a half miles. Hence the source is above the figure of equilibrium, and the waters flow as they do. The same mechanical causes, which originally swept the two oceans from the poles to the equator in order to build up that great equatorial embankment of water thirteen miles high, and thus give the earth a stable figure, are now carrying the Mississippi *to its mouth*, where the embankment is not yet high enough, and the Nile *from its source*, where the liquid embankment is too high. And here I may answer Mr. Mann's inquiry, 'Why does not the centrifugal motion of the earth drive the waters of the Atlantic and Pacific Oceans towards the equator?' It did once. But sufficient water has already gone to make the figure perfect now. Inasmuch as the earth's waters flow so as to restore the ideal figure of equilibrium wherever it is lost, and inasmuch as this figure of equilibrium is such that the resultant of gravity and the centrifugal force must be everywhere normal to its surface, the direction and the velocity of the flow are intimately connected with the centrifugal force. Without a rotation, and the centrifugal force which rotation produces, the earth's figure of equilibrium would be a sphere. In this event, the Mississippi would flow northward. Its southern direction, under existing circumstances, may therefore be fairly attributed to the centrifugal force. If the earth did not rotate, and the sphere were the figure of equilibrium, the Nile would flow in direction as it now does, but much more rapidly. Under existing circumstances, the same centrifugal force which accelerates the flow of the Mississippi retards the flow of the Nile.

"If the inquiry be made whether the Mississippi runs *up hill* or down, I reply that this is simply a question of definition. If *down* means towards the earth's centre of figure, then the Mississippi runs up. If *down* means towards that part of the earth's surface where the attraction is greatest, then also the Mississippi runs up. We cannot say, with Mr. Mann, that *down* means towards the earth's centre of gravity, because the earth has no single centre of gravity. His definition of *up* and *down*, therefore, is without any meaning, and is not, as he says, based upon the only philosophical idea we can have of these terms. The only standard level of altitude is the surface of equilibrium. If we understand by *down* 'below the surface of equilibrium,' and by *up* 'above the surface of equilibrium,' then our definitions will be as broad as nature's laws, and will lead to no paradoxes, all of which nature abhors more than a vacuum: then all the rivers will be found flowing downward. On a small scale, and in local mechanics, an inclined plane is one which is inclined to the local plumb-line. But on a large scale, such as will take in the whole length of a great river, every plane surface is inclined to every plumb-line but one, and the surface which is not inclined, and on which, therefore, a body has no tendency to slide, is a surface which is everywhere perpendicular to the plumb-lines which intersect it; that is, it is the earth's surface of equilibrium. This is the only true, broad, and universal standard of level.

"It may be concluded from what has been said, that the new hydrostatic paradox is of man's invention, and that nature is in no way responsible for it. Science abounds in such paradoxes; and men of science are too prone to array the merest truisms in paradoxical language which catches the popular ear, though at the sacrifice of making science itself vulgar. Moreover, if the explanation which I have given of the paradox under consideration is beyond the knowledge or above the comprehension of a child, then the question which involves it is unfit to be addressed to him."

Professors W. B. Rogers and D. Treadwell offered some remarks upon the subject, and expressed their concurrence in the view taken of it by Mr. Lovering.

DONATIONS TO THE LIBRARY,

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Academy of Natural Sciences of Philadelphia.

Proceedings, Vol. VII., Vol. VIII. No. 1. 8vo. Philadelphia.
Journal. New Series. Vol. III. Part II. 4to. Philadelphia.

Francis Wayland.

The Elements of Intellectual Philosophy. By Francis Wayland, President of Brown University. 1 vol. 12mo. Boston. 1854.

Academy of Sciences, Arts, and Belles-Lettres, Dijon.

Mémoires pour Années 1852 – 53. 2^{e} Série. Tome II. 8vo. Dijon.

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Mémoires, 1829, 1836, 1851, 1852. 4 vols. 8vo. Caen.

Julien Travers.

Rapport sur les Travaux de l'Académie des Sciences, Arts, et Belles-Lettres de Caen, lu dans Séance publique du 24 Novembre, 1853. Par M. Julien Travers, Secrétaire. 8vo pamph. Caen. 1854.

Biographie de Charles-Gabriel Porce. 8vo pamph. Caen. 1854.

L'Anti-Rouge Almanach, Anti-Socialiste, Anti-Communiste, etc. 12mo pamph. Paris. 1851.

Almanach Historique de la République Française contenant Ephemerides de 1848, etc. 12mo pamph. Paris. 1851.

Dionysii Catonis Disticha de Moribus ad Filium, in Gallicos Versus translata ; quibus accedit ad explanandas Quæstiones de Auctore et ejus Doctrina Morali Dissertatio. Opera Juliani Travers. 8vo pamph. Falesiae. 1837.

M. Lecerf.

De l'Organisation et de la Discipline des Églises Réformées de France. 8vo pamph. Caen. 1854.

Du Jeu considéré comme Amusement dans les Reunions de Parents et d'Amis. Etude Morale. 8vo pamph. Caen. 1852.

Tableau General et Raisonné de la Legislation Française, etc. 8vo pamph. Paris. 1841.

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T. A. Quevenne.

Archives de Physiologie de Therapeutique et d'Hygiene. No. 2. Oct. 1854.

Mémoire sur l'Action Physiologique et Therapeutique des Ferrugineux. 1 vol. 8vo. Paris. 1854.

Augustus A. Gould, M. D.

Search out the Secrets of Nature. The Annual Discourse before the Massachusetts Medical Society, at Springfield, June 27, 1855. 8vo pamph. Boston. 1855.

J. A. Lapham.

A Geological Map of Wisconsin. Fol. New York. 1855.

United States Patent-Office.

Report of the Commissioner of Patents for the Year 1854. Arts and Manufactures. 2 vols. 8vo. Vol. I. Text; Vol. II. Illustrations. Washington. 1855. (Pub. Doc.)

Col. W. H. Swift.

Reports of Explorations and Surveys, to ascertain the most practicable and economical Route for a Railroad from the Mississippi River to the Pacific Ocean, made under the Direction of the Secretary of War in 1853–54. With 3 maps. Vol. I. 4to. Washington. 1855. (Pub. Doc.)

E. E. Salisbury.

Phœnician Inscription of Sidon. (Extract from the Journal of the Am. Oriental Soc.) Vol. V. No. 1. 8vo pamph.

American Association for the Advancement of Science.

Proceedings of the Seventh Meeting, held at Cleveland, Ohio, July, 1853; Eighth, at Washington, D. C., May, 1854; Ninth, at Providence, R. I., August, 1855. 3 vols. 8vo. Cambridge. 1855-56.

American Oriental Society.

Journal. Vol. V. No. 1. 8vo pamph. New Haven. 1855.

Col. Edward Sabine, R. A.

Magnetical and Meteorological Observations at Lake Athabasca and Fort Simpson, by Capt. J. H. Lefroy, Royal Artillery; and at Fort Confidence in Great Bear Lake, by Sir John Richardson, C. B., M. D. Printed by order of Her Majesty's Government. 1 vol. 8vo. London. 1855.

Société des Sciences Naturelles de Cherbourg.

Mémoires. 2^e Tome. 8vo. Cherbourg. 1854.

Société Imperiale des Naturalistes de Moscou.

Bulletin de la Société. Tome XXVI., Année 1853, Nos. 3 et 4. Tome XXVII. Année 1854, No. 1. 8vo. Moscou. 1853-54.

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Bulletin de la Société. Tome III. pp. 95-182. 8vo. Neuchatel. 1854.

Lieutenant J. M. Gilliss.

The United States Naval Astronomical Expedition to the Southern Hemisphere during the Years 1849, 1850, 1851, 1852. Lieut. J. M. Gilliss, Superintendent. 2 vols. 4to. Washington. 1855. (Pub. Doc.)

Origin and Operations of the United States Naval Astronomical Expedition. 4to pamph. Washington. 1854.

William H. Prescott.

History of the Reign of Philip the Second, King of Spain. 2 vols. 8vo. Boston. 1855.

Essex Institute.

Act of Incorporation, Constitution, and By-Laws of the Essex Institute, incorporated February, 1848. With a Catalogue of the Officers and Members. 8vo pamph. Salem. 1855.

N. B. Shurtleff.

Thirteenth Report to the Legislature of Massachusetts, relating to the Returns of Births, Marriages, and Deaths in the Commonwealth for the Year ending December 31, 1854. By E. M. Wright, Secretary of the Commonwealth. 1 vol. 8vo. Boston. 1855.

G. W. Manypenny.

Information respecting the History, Condition, and Prospects of the Indian Tribes of the United States. Collected and prepared under the Direction of the Bureau of Indian Affairs, by Act of Congress of March 3d, 1847. By Henry R. Schoolcraft, LL. D. Illustrated by S. Eastman, Captain in the United States Army. Part V. 4to. Philadelphia. 1855.

Selectmen of Medford.

History of the Town of Medford, Middlesex County, Massachusetts, from its First Settlement in 1630 to the Present Time, 1855. By Charles Brooks. 1 vol. 8vo. Boston. 1855.

Royal Institution of Great Britain.

Notices of the Meetings of the Members. Part V. November, 1854 – July, 1855. 8vo pamph. London. 1855.

Zoölogical Society of London.

Transactions. Vol. IV. Parts 1 – 3. 4to. London. 1850 – 53.

Professor Sedgwick.

Description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge, by Frederick McCoy, F. G. S., &c. With a Synopsis of the Classification of the British Palæozoic Rocks, by the Rev. Adam Sedgwick, M. A., F. R. S., &c. Part II. Fasc. 3d. (Upper Palæozoic Molusca and Palæozoic Fishes.) 4to. London. 1855.

E. Clibborn.

An Essay on the Probability of Saul, Beniah, Abishai, Jehoshaphat, Jehdhannan, and Amessias, son of Zichri, having been the Hycsos Rulers, Salatis, Beon, Apachnas, Apophis, Jonias, and Assis. No. II. 8vo pamph. Dublin.

Henry D. Rogers.

Map of the Arctic Basin: its Limits, Features, Drainage, Currents, Winds, and Climates. (Plate XII. of Johnston's Phys. Atlas of Nat. Phenomena.) Fol.

Charles F. Barnard.

The Charities of Boston; or Twenty Years at the Warren Street Chapel. An Address delivered at the Chapel by Rev. William R. Alger, Sunday Evening, January 27, 1856. 8vo pamph. Boston. 1856.

Charles Brooks.

Elementary Course of Natural History. Being an Introduction to Zoölogy. Intended for the College and the Parlor. Elements of Ornithology. With Plates. 1 vol. 12mo. Boston. 1847.

History of the Town of Medford, Middlesex County, Massachusetts, from its First Settlement in 1630 to the Present Time, 1855. By Charles Brooks. 1 vol. 8vo. Boston. 1855.

The Commissioners of the Public Library.

Proceedings on the Occasion of Laying the Corner-Stone of the Public Library of the City of Boston. 1 vol. 8vo. Boston. 1855.

S. L. Abbot, M. D.

Report of the Board of Trustees of the Massachusetts General Hospital. Presented to the Corporation at their Annual Meeting, January 23, 1856. 8vo pamph. Boston. 1856.

Royal Academy of Sciences, Stockholm.

Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar-Tionde Årgången, 1853; Elfte Årgången, 1854. 2 vols. 8vo. Stockholm. 1854 – 55.

Four hundred and twenty-sixth meeting.

April 8, 1856. — MONTHLY MEETING.

The Academy met at the house of the Hon. John C. Gray. The President in the chair.

The Corresponding Secretary read a letter from Dr. J. P. Kirtland of Cleveland, Ohio, accepting Fellowship.

Mr. G. P. Bond presented a paper "On the Use of Equivalent Factors in the Method of Least Squares," which, on motion of Professor Lovering, was referred to the Committee of Publication.

Professor Eustis exhibited an apparatus illustrating a peculiar case of warped surfaces. The apparatus consisted of two planes at equal distances from each other, having upon their contiguous surfaces, and opposite to each other, figures of an ellipse. From the whole circumference of each of these ellipses cords were tightly drawn obliquely across to a corresponding but opposite point in the other. The effect, on looking through an aperture in the middle of the apparatus, was a very peculiar series of curves, resulting from the crossing of so many straight lines.

At the request of Professor Horsford, Dr. Charles T. Jackson stated that, in his recent examinations of Cochituate water, he had found the Crustacea, to which the impurity of that water in 1855 was attributed by some, quite numerous. A month since the Cyclops were as abundant as at any time, except when the water was first introduced into the city. They always contain more or less oil, of various colors. Dr. J. had collected a teaspoonful of them, and observed, on boiling, that they became of a bright orange-red color. He could perceive no disagreeable odor or taste to the oil; but when the mouth was rinsed with water containing it, it left a peculiar stinging sensation in the throat, resembling what Professor Horsford and himself had noticed in tasting the water of the lake *in situ.* The oil was always found in these Crustacea.

Dr. A. A. Gould remarked, that other observers had stated to him that the Crustacea are far less numerous this year than last, and contain much less oil. The number is found, as then, to vary very much at different times and places. He doubted if oil was found in them at all times. It was his impression, also, that it had been but recently noticed. In the figures and descriptions of them by European observers, he believed no delineation or mention of its existence occurred. On the authority of Professor Jeffries Wyman, who had been recently studying those found in the wells of the College yard, Cambridge, he stated that there was abundance of oil in the bodies of the specimens from that locality.

Dr. Jackson mentioned that one European observer had recorded its existence, namely, Kölliker.

In reply to a question of Professor Horsford, whether the animals in question ever feed on anything but vegetable food, Dr. Gould said that the Crustacea in general are known to be carnivorous. He could not speak positively with reference to the microscopic species.

Dr. Pickering said that no Crustacean had ever been known to feed on vegetable matter.

Professor Lovering exhibited and explained Wheatstone's photometer.

Dr. A. A. Gould made some statements concerning the supposed ejection of living animals from the human stomach, where they had been believed to have resided for some time, but which, from their structure and habits, could not have lived under such conditions. He mentioned several instances, — one that of a snake, supposed to have existed for months in a man's stomach, which on being opened was found to contain in its stomach another snake, of a different species, which it had swallowed; all tending to confirm the probability that all such stories are palpable fictions, or the offspring of honest delusion.

Four hundred and twenty-seventh meeting.

May 13, 1856. — MONTHLY MEETING.

The Academy met at the house of the Hon. Nathan Appleton. The President in the chair.

The Corresponding Secretary read letters from Rear-Admiral W. H. Smyth, acknowledging the donation of the Academy's Memoirs, and from Die Königlich Sächsische Geselschaft der Wissenschaften, and the Lyceum of Natural History, New York, acknowledging the donation of the Proceedings of the Academy.

Referring to the statements concerning the Cochituate water at the preceding meeting, Dr. A. A. Hayes said, that, in a paper read by him last year, he had demonstrated that the impurity existing at that time was due to an animal origin, and he had seen no reason to change his view since.

Dr. John Bacon remarked, that he had noticed the oil-containing Crustacea during the past year, especially in the very cold months, when there was very little vegetable matter in the water. He had seen no reason to change his former opinion concerning them.

Dr. C. T. Jackson said, that, shortly after the Cochituate water was introduced into Boston, he had collected great numbers of the Crustacea, at a time when the water was very pure.

Dr. Bacon had pointed out to him the oil in their bodies, a year before there was any complaint of any bad taste in the water. Afterwards, when the water was quite impure, they were much less numerous, and as the water became purer their number increased.

Dr. C. Beck said, that

"he had for some time been occupied with an attempt to give an answer to the question in what age Petronius Arbiter, the author of the Satyricon, lived and wrote. After remarking that Petronius was the most important and interesting of the small number of Latin prose-writers of fiction, and after giving a brief account of the contents of the Satyricon, so far as it is still extant, he adverted to some of the facts in the external history of the book. He stated that, from several circumstances, it is probable that the portion now left is not more than one fifth, and may be not more than one tenth, of the whole work; and that this loss of four fifths, or nine tenths, was sustained between the thirteenth and fifteenth century, because John of Salisbury, a writer of the thirteenth century, quotes passages from Petronius which are not to be found in the first printed editions of 1470 and succeeding years. He related the discovery of the Tragurian fragment, in 1663, at Tragurium in Dalmatia, which, containing the description of the banquet of Trimalchio, and forming one of the most important portions of the work, repaired the loss previously sustained to a small extent only. After speaking of the discussion to which this discovery gave rise, and the speedy acknowledgment of the genuineness of the fragment, he adverted, in a few words, to the bold fraud of Nodot, in attempting to pass upon the learned world, as genuine, a manuscript which he pretended to have found in Belgrade, but only with partial and temporary success.

"He next spoke of the great diversity of opinion among scholars as to the age of Petronius, some placing him as early as the times of Augustus, others as late as those of Constantine; a diversity of opinion ranging, therefore, over a period of three hundred years. After stating that perhaps the majority of scholars, of the present as well as past ages, — misled by the passage in the Annals of Tacitus, 16. 17 and following, in which is given the history of C. Petronius, a man of consular dignity, and, on account of his refined taste and skill in arranging and inventing new pleasures, for a time a great favorite of Nero, — had adopted the hypothesis that this Petronius was the author of the

Satyricon, and that the communication mentioned in Tacitus as having been sent by Petronius to the Emperor Nero was the Satyricon; and after showing that this hypothesis, however plausible, is untenable, he adverted to some of the principal difficulties in satisfactorily answering the question concerning the age of Petronius. One is the absence of all external evidence; since the passage in Tacitus, which by some has been considered as external evidence, unquestionably does not refer to the author of the Satyricon.

"This being the case, internal evidence alone remains, and this is naturally divided into two kinds, — the historical and linguistic. The former consists in allusions to persons, events, customs, and institutions, political as well as religious and social; the latter in peculiarities of language and style. The historical evidence leads, in Mr. Beck's opinion, to the conclusion that the work was written during the latter part of the reign of Augustus or the beginning of that of Tiberius, some time between the year 6 and 30 after Christ; and the evidence of language is not only compatible with that conclusion, but confirms it.

"After referring to the circumstance that one of the greatest literary excellences of the book, namely, the variety of styles occurring in the book, — since, besides the language of the narrative, which is simple and elegant, each character introduced into the story is represented, and with remarkable skill too, as using such language as is suited to his age, social station, and degree of education, — increased the difficulty of settling the question of the age of Petronius, he closed with the account given by Gellius of the word *fruniscor*, which is, in the Satyricon, put into the mouths of several individuals, as a specimen of the evidence of language having a bearing on the point in question."

Professor Jeffries Wyman gave an account of the peculiar structure of the organs of voice in the male Surinam toad.

Dr. A. A. Hayes exhibited a peculiar deposit in the tubes of the boilers of the Collins steamers, and explained his theory of its formation.

Dr. C. T. Jackson exhibited specimens of aluminium received from De Ville. The price of the metal in Paris is $100 a pound. Even if it should not be of great value in the arts, it would be very serviceable, from its extreme lightness, for delicate balances and weights.

Dr. Hayes said that the metal had already been applied for manufacturing purposes in Philadelphia. The price there was $108 a pound.

Dr. W. F. Channing also exhibited half an ounce of this metal, with a piece of silver of the same weight, to show their comparative specific gravities. He also showed some alloys of aluminium with silver, prepared by Mr. Farmer. For this purpose this metal would probably be found very valuable.

Four hundred and twenty-eighth meeting.

May 27, 1856. — ANNUAL MEETING.

The PRESIDENT in the chair.

The President reported from the Council a list of the Fellows, Associate Fellows, and Foreign Honorary Members chosen during the past year. Also a list of those deceased since the last annual meeting, viz.: —

Fellows deceased.

Hon. Abbott Lawrence,	Boston.
Dr. Thaddeus W. Harris,	Cambridge.
Hon. Charles Jackson,	Boston.
Hon. S. S. Wilde,	Boston.
Dr. John C. Warren,	Boston.

Associate Fellows deceased.

Dr. Elisha Bartlett,	Rhode Island.
Hon. William Cranch,	Washington.
Commodore Charles Morris,	Washington.

Foreign Honorary Member deceased.

Sir William Hamilton,	Edinburgh.

The Treasurer, the Committee on Publications, and the Committee on the Library, severally presented their annual reports.

The following gentlemen were elected Fellows, viz.: —

Hon. Thomas G. Cary,	Boston.
Rev. Dr. George E. Ellis,	Charlestown.
John B. Henck, Esq.	Boston.
Charles James Sprague, Esq.	Boston.

The annual election was held, and the following officers were chosen for the ensuing year: —

Jacob Bigelow, ...	*President.*
Daniel Treadwell, . .	*Vice-President.*
Asa Gray, ...	*Corresponding Secretary.*
Samuel L. Abbot, . . .	*Recording Secretary.*
Nathaniel B. Shurtleff,	*Librarian.*
Edward Wigglesworth, .	*Treasurer.*

Council.

Joseph Lovering, E. N. Horsford, Benjamin A. Gould, Jr.	of Class I.
Louis Agassiz, Jeffries Wyman, John B. S. Jackson,	of Class II.
James Walker, Francis Bowen, Nathan Appleton,	of Class III.

The several Standing Committees were appointed, on nomination from the chair, as follows: —

Rumford Committee.

Eben N. Horsford, Joseph Lovering,
Daniel Treadwell, Henry L. Eustis,
Morrill Wyman.

Committee of Publication.

Joseph Lovering, Louis Agassiz, C. C. Felton.

Committee on the Library.

Augustus A. Gould, Benjamin A. Gould, Jr.,
J. P. Cooke, Jr.

Auditing Committee.

THOMAS T. BOUVÉ, CHARLES E. WARE.

Professors Treadwell and Lovering and Mr. J. P. Hall were appointed a committee to consider the subject of the meteorological observations of the Academy.

Professor Gray made a brief communication on the placentation of certain *Gentianaceæ*, and the variable æstivation of the corolla in certain *Scrophulariaceæ*. His former pupil, Mr. Henry James Clark, of Cambridge, had recently shown him that in most of our North American Gentians the ovules are spread over the whole parietes of the ovary, either irregularly or in vertical lines on the veins; and on examination, the same thing was found to occur in *Bartonia*, Muhl. (*Centaurella*, Michx.) even more strikingly, the innumerable small ovules being thickly crowded over the whole inner surface of the ovary, just as in *Obolaria;* and even the somewhat cruciform shape of the transverse section of the ovary of *Obolaria* is repeated in *Bartonia paniculata*. These observations may be considered as decisive of the question of the true position, in the natural system, of *Obolaria*, so long viewed as anomalous; its affinities to the *Gentianaceæ*, long ago suggested by Nuttall, and advocated by Professor Gray in the third volume of the Memoirs of the Academy, being now perfectly confirmed. For this very placentation, which was naturally thought to indicate a relationship rather with the *Orobanchaceæ* (in which, however, this particular arrangement does not occur), now proves to be a confirmation of its affinity with the *Gentianaceæ*.

The only remaining obstacle to this view is the imbricated æstivation of the corolla of *Obolaria;* a character which Professor Gray could not consider of very great consequence, since a different deviation from the usual convolute æstivation is well known to occur in one tribe of the Gentian Family (the *Menyantheæ*). And as an instance of the occasional breaking down of this character, even in cases where it is generally stable and systematically important, he referred to the *Scrophulariaceæ*, and to some observations made by his pupil, Mr. Clark, several years ago, upon *Mimulus*, showing that this genus of the *Antirrhinideæ* not rarely has the lobes of the lower lip of the coralla external in æstivation, as in the *Rhinanthideæ*. Professor Gray had recently noticed the same thing in an anomalous still unpublished *Pentstemon*, which presented both modes of æstivation in different flower-buds of the same inflorescence.

The Corresponding Secretary communicated, from the author, the following

"*Synopsis of the Cactaceæ of the Territory of the United States and Adjacent Regions*, by George Engelmann, M. D., of St. Louis, Missouri.

"The only Cactus known to Linnæus from the countries north of Mexico was his *Cactus Opuntia* (*Opuntia vulgaris*). Long after him, more than forty years ago, Nuttall, the pioneer of West American botany, discovered two *Mamillariæ* and two *Opuntiæ* on the Upper Missouri, and again, twenty years later, in California, a new *Echinocactus*. About ten years ago we became acquainted with numerous new Cactaceæ, in Texas through Mr. F. Lindheimer; in New Mexico through Dr. A. Wislizenus; and in Northern Mexico through the same explorer and Dr. J. Gregg: some others (and among them the giant of Cacti) were indicated in the Gila country by the then Lieutenant W. H. Emory. Soon afterwards Mr. A. Fendler collected several new species about Santa Fé. Mr. Charles Wright, a few years later (1849), discovered in Western Texas and Southern New Mexico still other undescribed Cacti.

"But the greatest addition to our knowledge of the Cactaceæ of the southern part of the United States was made by the gentlemen connected with the United States and Mexican Boundary Commission, at first under Colonel Graham, and subsequently under Major Emory. Science is indebted principally to Dr. C. C. Parry, Mr. Charles Wright, Dr. J. M. Bigelow, Mr. George Thurber, and Mr. A. Schott, for valuable collections of living as well as dried specimens, and for full notes taken on the spot.

"About the same time, Mr. A. Trécul of France, and after him Dr. H. Poselger of Prussia, traversed Southern Texas and Northern Mexico, collecting many Cactaceæ, and increasing our knowledge of this interesting branch of botanical science.

"The Pacific Railroad expeditions since 1853 have opened fields not before explored; and Dr. Bigelow, the botanist and physician of Captain A. W. Whipple's expedition along the 35th parallel, availed himself of these opportunities in a most successful manner; while Dr. F. V. Hayden, almost unaided in his adventurous expedition, has extended our knowledge of the northernmost Cactaceæ in the regions of the Upper Missouri and Yellowstone Rivers.

"The last, but by no means least addition, was made in 1854 and 1855, by Mr. Arthur Schott, during the exploration under Major Emory of the country south of the Gila River, known as the Gadsden Purchase.

"Most of the materials brought together by these different explorers have come into the hands of the writer; but few of the discoveries made since 1847 and 1848 have been given to the public; — partly because the material on hand very often was incomplete, and partly because it seemed desirable to publish the whole in an elaborate form with the Reports of the Boundary Commission and those of the Pacific Railroad Surveys. These reports are now in preparation; but the splendid plates which are to illustrate the natural history of these plants cannot be finished for some time; it is therefore deemed advisable now to publish short descriptions of the new species, and systematically to arrange them with those before known.

CACTACEÆ.

Tribus I. TUBULOSÆ, Miquel.

Subtrib. 1. Parallelæ. Cotyledones margine hilum versus spectantes, lateribus seminis parallelæ.

I. MAMILLARIA, Haw.

Ovarium baccaque læves. Semina fere exalbuminosa. Cotyledones abbreviatæ, plerumque erectæ, subconnatæ. — Plantæ mamillato-tuberculatæ; inflorescentia laterali s. verticali.

Subgen. 1. Eumamillaria. Flores ex axillis tuberculorum anni prioris nunquam sulcatorum: ovarium plerumque immersum versus fructus maturitatem emergens.

§ 1. *Polyacanthæ*, Salm.

1. M. micromeris, E. in Bound. Comm. Rep.: parvula, simplex, globosa; tuberculis minimis verrucæformibus confertissimis; areolis

junioribus solum lana laxa vestitis; aculeis setiformibus cinereis pluriseriatis, in plantis junioribus sub 20 æqualibus lineam longis, radiantibus in tuberculis floriferis 30 – 40 undique stellato-porrectis, superioribus 6 – 8 longioribus clavatis; floribus minimis subcentralibus.

Var. β. Greggii: major, tuberculis majoribus aculeis paucioribus rigidioribus.

From El Paso eastward to the San Pedro River. Var. β. near Saltillo. From ½ to 1½ inches in diameter; β. often 2 inches or even more in diameter; tubercles ½ – 1 line long, spines ½ – 1½ lines long, in β. 1 – 2 lines long; uppermost spines of each areola in the fully developed plant 3 to 4 times as long as the others, and strongly clavate, surrounded by long and loose wool, which, together with the upper part of the long spines, breaks or falls off after fructification. Flowers (and even fruits) nearly central, 3 lines in diameter, light pink. — Near *M. microthele*, Muhlenp., which, however, has 2 central spines.

2. M. lasiacantha, E. l. c.: parvula, simplex, globosa; tuberculis teretibus; aculeis setiformibus pilosulis s. denudatis 40 – 80 pluriseriatis omnibus radiantibus; floribus lateralibus albidis.

On the Pecos River, in Western Texas: fl. in May. — Plant ½ to 1 or even 1½ inches high, and scarcely less in diameter; tubercles 2 – 3 lines long, spines 1½ – 2½ lines long. Flower whitish or very pale pink, 6 lines long. — *M. Schiedeana*, Ehrenb. seems to be similar, but is much larger, and has large tubercles with woolly axillæ, etc.

§ 2. *Crinitæ*, Salm.

A. *Aculeis centralibus rectis.*

3. M. pusilla, DC., var. Texana, E. l. c.: ovato-globosa, prolifera, cæspitosa; tuberculis teretibus axilla longe-lanatis; aculeis pluri-seriatis, extimis 30 – 50 capillaceis crispatis, interioribus 10 – 12 rigidioribus brevioribus albidis, intimis 5 – 8 longioribus rigidis rectis versus apicem fuscatis; floribus lateralibus rubellis.

On the Rio Grande, near Eagle Pass and southward: fl. April – June. — Plant 1 – 2 inches high; spines 3 – 6 lines, flowers 7 – 10 lines, long. — Seems scarcely distinct from the well-known West Indian *M. pusilla.*

B. *Aculeis centralibus uno alterove uncinato.*

4. ? M. barbata, E. in Wisl. Rep.: aculeis radialibus biseriatis, centrali singulo deorsum hamato; floribus subcentralibus; seminibus tenuiter scrobiculatis.

Cosiquiriachi, west of Chihuahua. This species has borne flower and fruit with me, and my notes and my recollections indicate that they were central: hence the mark of doubt above, as to the proper position of this species here, where all the other closely allied forms belong.

5. M. PHELLOSPERMA, E. in B. C. R. (M. tetrancistra, *E. in part, Sill. Jour. Nov.* 1852): ovata, subsimplex; tuberculis teretibus axilla lanata setigeris; aculeis radiantibus 40 – 60 biseriatis, exterioribus brevioribus tenuioribus, centralibus 3 – 4 robustioribus atrofuscis inferiore s. pluribus hamatis; floribus lateralibus; bacca pyriformi subsicca coccinea; seminibus globosis rugosis nigris massa fusca suberosa majore arilliformi auctis.

From the Gila to the eastern slope of the California mountains. — The name originally given had to be altered, because very rarely, if ever, are 4 hooked spines seen. In the original description this and the next species were confounded. — Plant 2 – 4 inches high. Radial spines 4 – 6 lines, central ones 5 – 9 lines long. — Apparently near *M. ancistroides*, Lem., which, however, has the radial spines all homogeneous.

6. M. GRAHAMI, E. l. c.: subglobosa, simplex s. demum e basi ramosa; tuberculis ovatis, axilla nudis; aculeis radiantibus 20 – 30 uniseriatis, centrali sursum hamato fuscato, additis sæpe 1 – 2 superioribus rectis; floribus lateralibus rubicundis; bacca ovata virescente; seminibus minutis scrobiculatis nigris.

Mountains from El Paso southward and westward to the Gila and Colorado, and up the latter river: fl. from June or July to August. — Plant 1 – 3 inches high; hooks much longer than the radial spines, which are 3 – 6 lines long. Flowers below the top, nearly one inch in diameter. Berry and seed small, the latter only 0.4 line long.

7. M. WRIGHTII, E. l. c.: depresso-globosa, simplex; tuberculis teretibus axilla nudis; aculeis radiantibus sub 12 albidis; centralibus sub-binis uncinatis fuscis vix longioribus; floribus lateralibus (?) purpureis; bacca subgloboso-ovata majuscula; seminibus scrobiculatis nigris.

New Mexico, on the Pecos and near the Copper Mines. — Plants $1\frac{1}{2}$ – 3 inches in diameter. Spines 4 – 6 lines long. Flowers fully one inch in diameter, bright purple, with narrow acuminate petals. Berry large and purple: seed 0.7 line long.

8. M. GOODRICHII, Scheer: ovato-globosa, subsimplex; tuberculis

brevi-ovatis axilla lanata setigeris; aculeis radiantibus 11 – 15 albidis, centralibus 3 – 4 fusco-atris, inferiore paulo longiore deorsum uncinato; floribus lateralibus.

San Diego, California. — Two or three inches high. Radial spines $2\frac{1}{2}$ – $3\frac{1}{2}$ lines long; the lower central spine a little longer. Flowers apparently yellowish-white, and half an inch in diameter.

§ 3. *Setosæ*, Salm.

9. M. BICOLOR, Lehm.: depressa, ovata, s. cylindracea, prolifera; axillis lanatis; tuberculis parvulis conicis; aculeis exterioribus 16 – 20 tenuissimis recurvato-radiantibus, centralibus 2 – 4 rigidis, majoribus albis apice nigris interdum subpollicaribus, supremo plerumque longissimo incurvo; floribus parvulis purpureis; stigmatibus 5.

Abundant on the calcareous hills of the Rio Grande below Laredo, Texas, *Dr. Poselger:* fl. June and July. — Plant 3 – 12 inches high, the larger specimens 2 – 3 inches in diameter; radial spines 1 – 2, lower central ones 4 – 5, the upper 6 – 10 lines long. Flower about 9 lines long.

§ 4. *Centrispinæ*, Salm. (All our species are simple and have a milky juice.)

10. M. HEYDERI, Muhlenpf. (1848): simplex, depresso-globosa; tuberculis elongatis pyramidatis subquadrangulatis; aculeis radiantibus 10 – 20 rectis, inferioribus longioribus, centrali singulo breviore; floribus lateralibus sordide rubellis; baccis elongato-clavatis; seminibus parvis rugulosis fulvis.

Var. *α.* APPLANATA (M. applanata, *E. in Pl. Lindh.* 1850): vertice applanato s. depresso, aculeis radialibus 15 – 22.

Var. *β.* HEMISPHÆRICA (M. hemisphærica, *E. l. c.*): vertice convexo, aculeis radialibus 9 – 12.

From San Antonio and New Braunfels, Texas, to Matamoras and westward to El Paso: fl. April, May. — Var. *α.* is the Northern and Western, and *β.* the Southern form. — *M. declivis*, Dietr. seems to belong here; but I have never met with a description of this plant.

11. M. MEIACANTHA, E. in B. C. R.: hemisphærica; tuberculis quadrangulato-pyramidatis compressis; aculeis paucis (5 – 9) rigidis rectis s. recurvatis, inferioribus paulo longioribus, centrali singulo erecto s. sursum flexo et cum cæteris radiante; floribus et baccis præcedentis.

Western Texas and New Mexico. — Very similar to the last; but tubercles larger, more compressed, more loosely arranged; the spines fewer and stouter; perhaps only a variety of it.

12. M. GUMMIFERA, E. in Wisl. Rep. Similar to the last two, but stouter; flower larger, darker, but otherwise little different. Radial spines 10–12; the lower ones much stouter and longer than the upper ones: central spines 1 or 2, shorter.

§ 5. *Longimammæ*, Salm.

13. M. SPHÆRICA, Dietr.: prolifera, cæspitosa; tuberculis ovato-elongatis acutatis; aculeis setaceis radialibus 12–14, centrali singulo subbreviore vix robustiore; floris magni tubo supra ovarium emersum constricto elongato; petalis flavis acuminato-aristatis.

Hill-sides on the Rio Grande near Eagle Pass; also Corpus Christi, on the Gulf. — Single specimens clavate, but often forming dense hemispherical masses. Tubercles 6–8 lines; spines 3–5 lines long. Flower 1½–2 inches long. Fruit not seen.

Subgen. 2. CORYPHANTHA. Flores e basi tuberculorum hornotinorum aculeiferorum sulcatorum, vel in vertice ipso oriundi: ovarium emersum.

§ 1. *Albifloræ.*

14. M. PAPYRACANTHA, E. in Pl. Fendl. (Mem. Amer. Acad. 1849). This interesting plant has been collected only in a single specimen, near Santa Fé, which, together with the dried flowers, is in my possession. Shape of tubercles not well distinguishable, doubtful whether sulcate or not; the lower ones proliferous. Spines compressed, flexible, of the consistency of stiff paper; 8 radiating and 3 or 4 central; the lowest one of these longest and broadest. Flowers white, central, an inch or more in length and width. Fruit not seen.

§ 2. *Flavifloræ.*

* *Laxifloræ.* (The originally central flowers are pushed aside by the continuous development of new tubercles.)

15. M. NUTTALLII, E.: simplex s. prolifera, cæspitosa; aculeis radialibus 10–17 setaceis rectis plerumque puberulis albidis, centrali singulo robustiore sæpius deficiente; sepalis fimbriatis et petalis flavidis apice parce denticulatis lanceolatis, s. lineari-lanceolatis acutis; stigmatibus 2–8 erectis vel patulis; bacca subglobosa tuberculis breviore coccinea; seminibus globosis scrobiculatis nigris.

Var. *a.* BOREALIS (M. Nuttallii, *E. l. c.* Cactus mamillaris, *Nutt. Gen.*, 1818, *non Linn.*): subsimplex; aculeis setaceis 13–17 cum centrali sæpe deficiente puberulis; stigmatibus 2–5; baccis seminibusque minoribus.

Var. β. CÆSPITOSA (M. similis, *E. in Pl. Lindh.* 1845): cæspitosa; aculeis radialibus 12–15 puberulis, centrali plerumque deficiente; floribus baccis seminibusque majoribus; stigmatibus 5 patulis.

Var. γ. ROBUSTIOR, E. in Pl. Lindh. 1850: subsimplex; tuberculis longioribus laxioribus, aculeis robustioribus lævibus, radialibus 10–12, centrali singulo; floribus majoribus; stigmatibus 7–8 patulis; seminibus ut in β.

Plains east of the Rocky and New Mexican Mountains. Var. α. on the Upper Missouri; β. from Kansas River to New Braunfels in Texas; γ. from the Canadian River to the Colorado of Texas. The heads are one or two inches in diameter; the cæspitose masses of β. often a foot broad; spines 3–8 lines long. Flowers 1–2 inches long and wide, of a greenish or reddish or pure pale yellow color. Seeds 0.8–1.1 lines in diameter, more regularly globose than in most other Cactacæ.

16. M. SCHEERII, Muhlenpf. 1847; β. ? VALIDA, E. in B. C. R.: magna, ovato-globosa, subsimplex, glaucescens; tuberculis remotis patulis magnis e basi lata subcylindricis supra sulco profundo glandulis paucis munito (juniore lanato) subbilobis; areolis junioribus dense lanatis; aculeis 10–20 rectis robustis basi bulbosis albidis s. citrinis apice fuscatis, radialibus 9–16; centralibus 1–5 validioribus angulatis; floribus flavis ex axillis junioribus tomentosissimis.

Sandy ridges in the valley of the Rio Grande near El Paso: fl. July. The largest of our Northern Mamillariæ, 7 inches high and 5 in diameter; tubercles 1–1½ inches long; spines 10–18 lines in length, very stout, especially the central and lower radial ones. Flower 2 inches long, yellow. Fruit not seen. — *M. Scheerii* from Chihuahua, according to Prince Salm's description, is a smaller plant, with single central spines one inch in length, and 8–11 much shorter radial spines; the areolæ are described as naked: — nevertheless our plant is probably only the northern form of this species.

17. M. ROBUSTISPINA, A. Schott, in litt.: simplex s. cæspitosa; tuberculis patulis teretibus magnis sulcatis; areolis junioribus dense tomentosis; aculeis radialibus 12–15 robustis inferioribus robustioribus sæpe curvatis, superioribus rectis fasciculatis paullo tenuioribus, centrali singulo valido compresso recurvato, omnibus subpollicaribus corneis apice atratis; floribus luteis ex axillis junioribus tomentosissimis; seminibus magnis obovatis fuscis lævibus.

Sonora, on grassy prairies: fl. July. Tubercles nearly an inch

long, and an inch distant from one another; spines 9 – 15 lines long. Flowers 2 inches long, characterized by a very slender, constricted tube, very different from the wide tube of the foregoing species. Seeds fully 1½ lines long, larger than those of any other Mamillaria examined by me: embryo with some albumen, curved; cotyledons foliaceous! approaching the structure of the seed of most Echinocacti.

18. M. RECURVISPINA, E. in B. C. R.: simplex, depresso-globosa; tuberculis ovatis profunde sulcatis confertis; areolis obliquis ovatis, aculeis radialibus 12 – 20 rigidis recurvis intertextis albidis corneisve, aculeo centrali singulo (raro binis) robustiore longiore decurvato; floribus flavicantibus extus fuscatis ex axillis junioribus villosissimis.

Sonora: fl. July. Single heads 3 – 8 inches in diameter; tubercles 5 – 6 lines long; spines 4 – 9 lines long, upper ones often a little longer than the lower ones; central spine 6 – 10 lines long, darker. Flowers 1½ inches long. — This plant bears the closest resemblance to the next species, and must perhaps be classed with it; but in the dry specimen before me the flowers are not exactly vertical, as in that species.

* * *Densifloræ.* (Flowers and fruit remain central in the very woolly vertex of the plant, no new tubercles being developed before the fruit falls off; berries of all the species known to me oval, green; seeds brown, smooth.)

19. M. COMPACTA, E. in Wisl. Rep.: simplex, depresso-globosa; tuberculis abbreviato-conicis sulcatis confertis; areolis ovato-lanceolatis, aculeis radialibus 13 – 16 rigidis recurvis intertextis albidis corneisve, aculeo centrali erecto plerumque deficiente; floribus flavis extus fuscatis minoribus.

Cosiquiriachi, west of Chihuahua: fl. June and July. Plant 2 – 4 inches in diameter; distinguished from the last species by the acutish (not obtuse) tubercles, the more elongated areola, the erect central spine, which however is wanting in most specimens, and principally by the smaller and truly vertical flowers. Spines 5 – 10 lines long; flower 1¼ – 1½ inches long and wide; seed 0.7 line long.

20. M. PECTINATA, E. in B. C. R.: simplex, globosa; tuberculis conicis abbreviatis, summis floriferis teretibus longioribus sulcatis; areolis oblongis; aculeis 16 – 24 rigidis recurvis intertextis subæqualibus s. in tuberculis summis superioribus longioribus fasciculatis omnibus radiantibus corneis s. albidis; floribus magnis sulphureis.

On the Pecos River, in Western Texas: fl. July. — Plant 1 – 2 inches in diameter. Lower tubercles 2 – 3, floriferous ones 5 – 6 lines long; spines 3 – 5, upper fasciculated ones 6 – 9 lines long. Flower 2½ – 3 inches in diameter; seed 0.9 line long.

21. M. ECHINUS, E. l. c.: simplex, globosa; tuberculis tereti-conicis; areolis orbiculatis; aculeis rectis s. paullo curvatis intertextis albidis; radiantibus 16 – 30 summis paullo longioribus, centralibus 3 – 4, inferiore robustissimo subulato porrecto, superioribus 2 – 3 et cum radiantibus erectis; floribus magnis.

With the former. — Plant 1½ – 2½ inches in diameter; tubercles 5 – 6 lines long; lower and lateral spines 4 – 6, upper ones 6 – 10 lines long; upper central spines of the same length, and the lower central one a little shorter. This last one is unusually stout, subulate from a very thick base, and perpendicular on the centre of the plant, which gives it a very peculiar aspect. Flowers apparently about 1½ or 2 inches long.

22. M. SCOLYMOIDES, Scheidw. (1841): globosa s. ovata, subsimplex; tuberculis conicis, superioribus elongatis incurvis imbricatis; aculeis radiantibus 14 – 20 rectis s. plerumque recurvis albidis s. corneis, superioribus longioribus, centralibus 1 – 4 longioribus obscurioribus curvatis, superioribus sursum versis cum radialibus implicatis, inferiore robustiore longiore decurvo.

South of the Rio Grande; not yet discovered in our territory. — Plant 2 – 3 inches high; tubercles 5 – 8 lines long; radial spines 5 – 10 lines, the central ones 9 – 16 lines long. Flowers yellow, 2 inches long. — Perhaps this and both the foregoing species are only forms of the Mexican *M. cornifera*, of De Candolle. Only a close examination of these plants in their native wilds will enable us to decide this point.

23. M. CALCARATA, E. in Pl. Lindh. 2, 1850 (M. sulcata, *E. in Pl. Lindh.* 1, 1845. M. strobiliformis, *Muhlenpf.? non Scheer*): globosa, prolifera, cæspitosa; tuberculis e basi dilatata ovatis conicis; aculeis albidis, radialibus 8 – 10 rigidis subulatis rectis s. paullo recurvis, additis subinde ex summa areola aculeis adventitiis 3 – 5 fasciculatis tenuioribus, centrali singulo robustiore subulato recurvato, in plantis junioribus deficiente; floribus magnis sulphureis intus basi rubicundis.

Texas, from the Brazos to the Nueces rivers: fl. May. — Larger heads 2 – 2½ inches in diameter; cæspitose masses a foot or more large; tubercles spreading, or in older flowering plants often somewhat adpressed and imbricate, 7 – 9 lines long; spines 4 – 8 lines

long. Flower 2¼ – 2½ inches long, and of same diameter. Seeds a line long.

§ 3. *Rubrifloræ.*

* *Sepalis integerrimis.*

24. M. CONOIDEA, DC. (M. strobiliformis, *E. in Wisl. Rep. non Scheer*): found only south of the Rio Grande.

* * *Sepalis fimbriatis.*

25. ? M. POTTSII, Scheer: cylindrica, subramosa; tuberculis ovatis obtusis levissime sulcatis, axillis sublanuginosis; aculeis radialibus numerosissimis gracilibus albis, centralibus 6 – 12 validioribus expansis basi nodulosis apice sphacelatis; floribus magnis e viridi rubellis; baccis roseis.

Texas, on the Rio Grande, below Laredo, and from there to Chihuahua. — I have not seen this plant; the description is taken from Salm and Poselger.

26. M. TUBERCULOSA, E. in B. C. R.: ovata s. ovato-cylindrica, simplex s. ad basin parce prolifera; tuberculis e basi rhomboidea ovatis abbreviatis obtusis profunde sulcatis demum suberosis persistentibus confertis, axillis villosissimis; aculeis exterioribus 20 – 30 rigidis albidis, interioribus 5 – 9 robustioribus cæsio-purpureis sphacelatis, superioribus longioribus erectis, infimo breviore robusto porrecto s. deflexo; floribus in vertice densissime tomentoso centralibus pollicaribus dilute roseis; baccis elongato-ovatis rubris; seminibus minimis scrobiculatis.

On the mountains near El Paso, and eastward.: fl. May and June. Plant 2 – 5 inches high; tubercles 2½ – 3 lines long, dry and hard, not fleshy unless very young, nor shrivelling when old, but losing the spines and covering the lower part of the plant like corky protuberances. Outer spines usually 2 – 4, rarely 5 or 6, lines long; interior spines 4 – 9 lines long; those of the upper tubercles forming a tuft of grayish-purple color on top of the plant. Flowers very pale purple, one inch in diameter. Berry red, three fourths of an inch long, one fourth of an inch thick, crowned with the remains of the flower. Seeds short, thick, about half a line long. — The short, corky tubercles, with very deep grooves, and very woolly when young, together with the long red fruit, distinguish our species from all the allied forms.

27. M. DASYACANTHA, E. in B. C. R.: simplex, subglobosa; tuber-

culis teretibus laxis leviter sulcatis; axillis subvillosis; aculeis rectis tenuibus setaceis patulis, exterioribus 25 – 35 albidis, interioribus 7 – 13 longioribus purpureo-fuscis, centrali infero æquilongo; baccis centralibus ovatis; seminibus obovato-globosis nigricantibus scrobiculatis.

El Paso and eastward. — Specimens before me are 1½ – 2½ inches high, and a little less in diameter; tubercles 4 – 5 lines long; spines more slender and soft than in the allied species, often capillary, spreading, but not radiating, 6 – 12 lines long, only the lower exterior ones a little shorter. Seeds about half a line long. Very nearly allied to the next.

28. M. VIVIPARA, Haw.: simplex s. cæspitosa; tuberculis teretibus laxis leviter sulcatis; aculeis rectis rigidis, exterioribus patentissime radiantibus albidis 12 – 36, centralibus 3 – 12 robustioribus longioribus obscurioribus, singulo robustiore porrecto deflexove, ceteris sursum divergentibus; floribus subcentralibus purpureis magnis; baccis sublateralibus ovatis viridibus; seminibus obovatis scrobiculatis fulvis.

Var. *a.* VERA: depresso-globosa, simplex s. plerumque prolifera, cæspitosa; aculeis radialibus 14 – 20, centralibus 3 – 8.

Var. ? *β.* RADIOSA: ovata s. subcylindrica, simplex s. e basi ramosa; aculeis radialibus 12 – 36, centralibus 3 – 12. Subvar. *a.* RADIOSA BOREALIS: subglobosa; aculeis radialibus albidis 12 – 20, centralibus 3 – 6 purpureo-maculatis; floribus minoribus. — *b.* RADIOSA NEO-MEXICANA: ovata; aculeis radialibus albidis 20 – 36, centralibus 3 – 12 supra purpurascentibus sphacelatis; floribus majoribus. — *c.* RADIOSA TEXANA: ovato-cylindrica; aculeis radialibus albidis 20 – 30, centralibus 4 – 5 flavis s. fulvis; floribus seminibusque magnis. M. radiosa, *E. in Plant. Lindh.* 2. 1850.

In the Western plains, and on the Rocky Mountains: var. *a.* on the Upper Missouri and Yellowstone Rivers; *β. a.* in Northern New Mexico; *β. b.* from Western Texas to New Mexico and Sonora; *β. c.* in Texas, west of New Braunfels. — The extreme forms are certainly very unlike one another, but the transitions are so gradual that I cannot draw strict limits between them. Even the proliferous growth of the original *M. vivipara* is not constant, and I have seen many simple specimens from the Upper Missouri. The simple ones seem to flower better than the proliferous ones, which are often sterile. — Plants from 1 to 5 inches high, 1½ – 2 inches in diameter; tubercles 4 – 6 lines long; spines always rigid, 3 – 10 lines long. Flowers different in size, 1½ – 2½ inches in diameter, beautifully purple, with numerous narrowly lanceolate acuminate petals. Seeds ½ – 1 line long.

29. M. MACROMERIS, E. in Wisl. Rep. (M. dactylothele, *Lab.*): simplex s. e basi ramosa, ovata; tuberculis magnis patulis, laxis, tenuiter ultra medium sulcatis; aculeis tenuibus elongatis rectis s. paullo curvatis exterioribus 10 – 17 albidis, centralibus sub-4 longioribus robustioribus subangulatis, fuscis s. nigricantibus; floribus ex areolis supra-axillaribus in tuberculo ipso oriundis magnis; bacca subglobosa viridi; seminibus parvis lævibus fuscis.

In the valley of the Rio Grande, from Southern New Mexico to the middle course of the river near Presidio, and even lower down: fl. July and August. — A most remarkable species in many respects, and forming a transition to Echinocactus, though the mamillate form is so very striking. Plant 2 – 4 inches high; tubercles variable, 6 – 8 or 10 – 12 and even 15 lines long. Radial spines ½ – 1½ inches long; central ones often 1½ – 2¼ inches in length. Axils always naked. Flower springing from the lower end of the groove, which runs down about two thirds of the tubercle, 2½ – 3 inches in diameter, rose-colored or purple; not rarely with a few sepaloid scales on the ovary (and fruit). Seeds thick, but only 0.6 – 0.8 line long.

Subgen. 3. ANHALONIUM. (Gen. Anhalonium, *Lem.* Ariocarpus, *Scheidw.*) Flores e basi tuberculorum hornotinorum triangularium subinermium vel in vertice ipso oriundi: ovarium emersum.

30. M. FISSURATA, E. in B. C. R.: simplex, depresso-globosa s. applanata; tuberculis e basi applanata crassis extus infraque lævibus, supra sulco centrali villoso lateralibusque glabris profunde quadripartitis sulcisque transversalibus superficialiter multifidis, inermibus; floribus e villo longo sericeo centralibus roseis; baccis ovatis virescentibus in lana densa occultis; seminibus nigris tuberculatis.

On the limestone hills, near the junction of the Pecos with the Rio Grande: fl. October. Heads 2 – 4½ inches in diameter; tubercles 6 – 10 lines long, and a little less broad; central longitudinal groove in the very young ones bearing dense silky wool over half an inch long, which by age becomes dirty and matted, and finally disappears entirely in the very old ones. The lower end of the groove, which only extends down as far as the rough or verrucose part of the tubercle goes (about two thirds downward), bears the flower and fruit, very much like the floriferous areola of the last-mentioned species. Flower about one inch long and wide. Seed very roughly tuberculated, different from that of any other *Mamillaria* examined by me, but quite similar to that of other *Anhalonia.*

II. ECHINOCACTUS, Link. & Otto.

Ovarium emersum baccaque sepalis stipata. Semina sæpe albuminosa. Cotyledones plus minus foliaceæ plerumque hamatæ. — Plantæ subglobosæ, costatæ; inflorescentia verticali.

§ 1. *Hamati*, Salm.

1. E. **Scheerii**, Salm: globosus s. ovatus; costis 13 obtusis interruptis; tuberculis supra ad medium sulcatis; aculeis radialibus 15–18 setaceis, centralibus 3–4 angulatis variegatis, superioribus rectis longioribus sursum divaricatis, inferiore robustiore breviore hamato; floribus minoribus flavo-virescentibus; bacca virescente; seminibus fuscis.

About Eagle Pass, on the Rio Grande: fl. August to October. — A most elegant little species, 1½–2 inches high; larger spines black and white variegated; radial ones 3–6, central ones 6–12 lines long; floriferous areola united by a groove of 1–2½ lines in length with the spines, resembling the groove of the *Coryphanthæ*, especially of *Mamillaria macromeris*. Green flower an inch long, much less in diameter.

2. E. **brevi-hamatus**, E. in B. C. R.: obovato-globosus; costis 13 compressis obtusis interruptis; tuberculis supra usque ad basin sulcatis; aculeis radialibus 12 teretibus albidis, centralibus 4 complanatis, lateralibus rectis sursum versis paullo longioribus, summo debiliore et infimo robustiore deorsum hamato brevioribus; floribus minoribus roseis.

On the San Pedro, and about Eagle Pass: fl. April. — Very similar to the last; but larger, 3–4 inches high, with fewer spines, the lower central usually hardly longer than the upper radial ones, about one inch long; lower radial spines shorter, and upper central ones longer. The rose-colored flowers are 12–16 lines long, much less wide. Fruit unknown.

3. E. **Whipplei**, E. & B. in Pacific R. R. Rep.: ovato-globosus; costis 13–15 interruptis; aculeis radialibus 7 compressis albidis, centralibus 4 longioribus robustioribus compresso-quadrangulatis, summo latiore longiore, infimo robustiore deorsum hamato; seminibus magnis nigris.

On the Colorado-Chiquito, in Western New Mexico. — Plant 3–5 inches high; exterior spines 6–9 lines, upper central spine 12–18

lines long, and ½ – 1¼ lines broad; other central spines a little shorter. Seed very large, over 1½ lines in the longest diameter. — Principally characterized by the few radial spines and the very broad upper central one, which with the former forms an almost regular circle.

4. E. POLYANCISTRUS, E. & B. l. c.: ovatus, s. ovato-cylindricus; costis 13 – 17 interruptis; aculeis radialibus sub-19 complanatis albis, superioribus latioribus longioribus, inferioribus setaceis, centralibus difformibus, summo complanato elongato sursum curvato albo, reliquis 5 – 10 teretiusculis purpureo-fuscis, superioribus 2 rectis, ceteris uncinatis.

Eastern slope of the California mountains, at the head of the Mojave River. — Plant 4 – 10 inches high, 3 – 4 in diameter; radial spines ½ – 2 inches long; upper central spine 3 – 5, the others 1½ – 3½ inches long, the lowest shorter than the others. The number of the hooked spines varies from 3 to 7, according to age and development.

5. E. UNCINATUS, Hopf., var.? WRIGHTII, E. in B. C. R.: glaucescens, ovatus; costis 13 interruptis; tuberculis usque ad basin sulcatis; aculeis radialibus 8, inferioribus 3 uncinatis fuscis, reliquis 5 rectis, centrali singulo angulato complanato flexuoso hamato elongato erecto stramineo apice fusco; floribus fusco-purpureis minoribus.

Near El Paso and on the Rio Grande below: fl. March and April. — Plant 3 – 6 inches high, 2 – 3½ inches in diameter; the tuft of long, erect, straw-colored spines is very characteristic. Lower hooked radial spines about an inch long; upper ones a little longer; central spine 2 – 4 inches long. Flowers 1 – 1½ inches long. Berry fleshy, scaly. Seeds much compressed. — The Mexican *E. uncinatus* has 7 – 8 radial spines, similarly arranged, and 4 central spines; the three upper ones not much longer than the upper radial ones and straight, the lower one elongated and hooked. The flower and seed differ also to some extent.

6. E. SETISPINUS, E. in Pl. Lindh. 1845: globosus, ovatus s. subcylindricus; costis 13 compressis acutatis angulatis; tuberculis brevissime sulcatis; aculeis radialibus 10 – 16 setaceis; centrali subsingulo robustiore terete fusco uncinato s. flexuoso curvato; floribus magnis flavis intus coccineis; bacca pisiformi coccinea; seminibus tuberculatis.

Var. α. HAMATUS: aculeis radialibus sub 12, centrali hamato robusto. — E. hamatus, *Muhlenpf.* E. Muhlenpfordtii, *Fen.*

Var. β. SETACEUS: minor; aculeis pluribus, centralibus 1 – 3 tenuioribus vix hamatis.

Texas, from the Colorado to the Rio Grande, and westward as far as the San Pedro River: fl. April to October. — It is unnecessary further to describe this well-known and well-characterized species, which is now frequently cultivated; the compressed ribs, setaceous spines, small red berry, and tuberculated seeds easily distinguish it from all its allies.

7. E. SINUATUS, Dietr. (1851): globosus; costis 13 compressis acutiusculis interruptis; aculeis radialibus setaceis, 3 superioribus et 3 inferioribus rectiusculis fuscatis 1, lateralibus 2 – 6 tenuioribus albidis flexuosis, rarissime hamatis; centralibus 4 robustioribus, 3 superioribus rectis purpureo-variegatis, inferiore compresso seu canaliculato elongato flexuoso vel hamato stramineo; floribus magnis flavis; bacca ovata viridi; seminibus minutissime punctatis.

Country along the Rio Grande near Eagle Pass, and from there eastward. — Intermediate between the foregoing and the next species, and considered by Dr. Poselger a connecting link between them; but easily distinguished from the former by the larger size, thicker ribs, flattened central spine, and by the shining, finely dotted seeds; from the latter, to which it approaches much more closely, by the more compressed and less strongly tuberculated ribs, the smaller number of stigmata (8 – 12), smaller fruit, and much more finely dotted seed. — Poselger considers this a variety of *E. setispinus*. His *E. setispinus*, var. *robustus*, has the same seeds, and no doubt also belongs here; it is said to have all the 4 central spines, and some of the radial ones, hooked. *E. Treculianus*, Lab. belongs here, or perhaps to the next.

8. E. LONGEHAMATUS, Gal.: subglobosus; costis 13 – 17 obtusis tuberculato-interruptis; tuberculis breviter sulcatis; aculeis radialibus rigidis subteretibus, infimis summisque ternis, lateralibus 2 – 6 longioribus; centralibus 4 robustis angulatis annulatis, quorum infimus deorsum hamatus rectus seu flexuosus, additis subinde 2 – 4 superioribus cum radialibus superioribus fasciculatis; floribus magnis flavis; stigmatibus 15 – 18; bacca oblonga virescente squamosa; seminibus lucidis exsculptis.

Var. *α*. CRASSISPINUS: aculeis robustissimis radialibus 8 – 11, centralibus 4 angulatis, infimo flexuoso plus minus hamato. E. flexispinus, *E. in Wisl. Rep.* non *Salm.*

Var. *β*. GRACILISPINUS: aculeis gracilioribus 16 – 20, exterioribus 12 – 14, centralibus 4 – 8, infimo elongato hamato. E. hamatocanthus, *Muhl.*

Var. γ. BREVISPINUS: aculeis gracilioribus radialibus 8 – 11, centralibus 4 teretibus cum infimo hamato radiales vix superantibus.

East of El Paso, near the Pecos and San Pedro Rivers, and along the middle course of the Rio Grande: var. α. south of the Rio Grande. Fl. July and August. — Plants from ½ – 2 feet high; the larger ones ovate; areolæ distant; spines very different in size, in the different varieties; radial spines 1 – 3½, central spines 1½ – 6½ inches long; flowers 2½ – 3½ inches long; seeds similar to the last, but with much larger pits.

§ 2. *Cornigeri.*

A. *Heteracanthi.*

9. E. WISLIZENI, E. in Wisl. Rep.: giganteus, globoso-ovatus; costis 21 compressis crenatis; areolis elongatis; aculeis radialibus summis infimisque 6 robustis rectis seu curvatis, lateralibus 14 – 20 (additis subinde summis brevioribus fasciculatis) tenuibus elongatis flexuosis; centralibus 4 robustis angulatis annulatis rubellis, 3 superioribus rectis, inferiore canaliculato deorsum hamato; floribus flavis; bacca ovata squamosissima; seminibus reticulatis.

Valley of the Rio Grande about El Paso, and thence to the Upper Gila: fl. July and August. — Plant 2 – 4 feet high; diameter smaller; radial spines 1 – 2, central ones 1½ – 3 inches long. Flowers 2½ inches long.

10. E. LECONTEI, E. in P. R. R.: giganteus, obovato-claviformis; costis 20 – 30 compressis crenatis; areolis elongatis; aculeis radialibus summis infimisque 6 – 10 robustis angulatis plus minus curvatis, lateralibus 10 – 16 (addidis subinde summis brevioribus fasciculatis) tenuibus elongatis flexuosis, centralibus 4 robustis compressis annulatis corneis, 3 superioribus sursum inferiore subinde subhamato deorsum curvatis; floribus flavis; bacca ovata squamosa; seminibus scrobiculatis.

On the lower parts of the Gila and Colorado Rivers, and in Sonora: fl. August and September. Very similar to the last, but a more slender, often quite clavate plant; larger specimens 3 – 4 feet high, and of only one third that diameter; arrangement of spines similar, but generally 5 (not 3) radial spines below the lowest central one; central spines more compressed, upper ones curved, lower one rarely somewhat hooked; flower, fruit, and seed smaller; seed more oblong and pitted.

E. INGENS, Zucc., in the number and arrangement of spines, is the simple type of our more northern species: it has on the oval areolæ 4 stout cruciate central spines, 3 upper and 3 lower radial ones, and only 2 slender lateral spines. Seeds smooth. The flower seems to refer it, however, to the *Eriocarpi*.

B. *Homœacanthi.*

* *Lepidocarpi.*

11. E. EMORYI, E. (in Emory's Rep. 1848, and B. C. R.): grandis, ovatus; costis 13 – 20 obtusis tuberculatis; areolis ovatis; aculeis radialibus 7 – 8 subæqualibus robustis subangulatis annulatis paullo recurvatis rubellis 1 – 2 pollicaribus, centrali singulo recurvo s. subhamato paullo robustiore; floribus magnis purpurascentibus.

Lower Colorado, and principally in Sonora: fl. August and September. Larger plants 2½ – 3 feet high; spines usually 1 – 2, and, in a large specimen from Guaymas, nearly 3 inches long. Flowers about 3 inches long. Fruit unknown.

12. E. VIRIDESCENS, Nutt.: globosus, simplex seu raro ramosus; costis 13 – 21; aculeis robustis compressis annulatis plus minus curvatis rubellis, radialibus 12 – 20 infimo breviore magis curvato; centralibus 4 angulatis robustioribus longioribus, infimo rectiore longiore; floribus virescentibus; bacca squamosa; seminibus minutissime scrobiculatis.

San Diego, California. — Less than a foot in diameter, globose or flattened; radial spines 5 – 10 lines long, 3 upper central ones a little longer, and lower central spine 12 – 18 lines long. Flower 1½ inches long.

13. E. CYLINDRACEUS, E. in Sill. Jour. 1852: ovatus seu subcylindricus, plerumque e basi ramosus; costis 21 vel pluribus; aculeis robustis compressis annulatis plus minus curvatis flexuosisve rubellis, radialibus sub – 12, aculeis adventitiis sub – 5 gracilioribus supra sæpe adjectis, infimo hamato, centralibus 4 angulatis robustissimis cruciatis, superiore latiore sursum recto, inferiore decurvato; floribus flavis; bacca squamosa.

San Felipe, on the eastern slope of the Californian mountains: fl. in June. — The largest specimens seen were 3 feet high and one foot in diameter; the branches or young single plants are globose. Radial spines 1 – 2 inches long; central spines 1 – 1½ lines broad, about 2 inches long. Similar to the last, but well distinguished by the characters indicated.

* * *Eriocarpi.*

14. E. POLYCEPHALUS, E. & B. in P. R. R.: ovatus seu demum cylindricus, e basi ramosus; costis 13–21 acutis; aculeis robustis compressis annulatis plus minus curvatis rubellis, radialibus 4–8, infimo deficiente, superioribus (si exstant) gracilioribus; centralibus 4 angulatis compressis, superiore latiore suberecto vel sursum curvato, inferiore longiore decurvo; floribus flavis dense lanatis; bacca sicca; seminibus magnis angulatis.

On the Mojave, Colorado, and Gila Rivers: fl. February and March. — Single only when young, forming bunches of 20–30 cylindric equal-sized heads when older; the largest seen were 2–2½ feet high and about 10 inches in diameter. Exterior spines 1–2, interior ones 1½–3½, inches long. — Shape very much like the last, but the flower very distinct.

15. E. PARRYI, E. in B. C. R.: simplex, globosus vel depressus; costis 13 acutis; aculeis robustis angulatis annulatis albidis, radialibus 8–11, rectis s. paullo curvatis superioribus gracilioribus, infimo deficiente, centralibus 4 paullo longioribus robustioribus, infimo longiore decurvo; bacca sicca dense lanata.

West and southwest from El Paso. — Plant always single; largest specimens 8–12 inches high by 10–15 in diameter. — Very similar to the last; but apparently distinct by the manner of growth and the white spines. Unfortunately, no seeds were collected.

16. E. HORIZONTHALONIUS, Lem., var. CENTRISPINUS, E. in B. C. R.: glaucus, depressus seu demum ovatus; costis 8 obtusissimis latissimis; areolis orbiculatis basi truncatis; aculeis robustis compressis annulatis recurvatis rubellis demum cinereis, radialibus 5–7 superioribus debilioribus, infimo deficiente, centrali singulo robustiore decurvato; floribus purpureis dense lanatis; bacca sicca lanata; seminibus magnis angulatis.

From Doñana, above El Paso, to the Pecos, and southward: fl. April and May. — Plant 2–8 inches high and 3–6 in diameter; spines ¾–1½ inches long, nearly equal. Flower 2½ inches long, but partly enveloped in dense wool. The original *E. horizonthalonius* is said to have no central spine, and linear-lanceolate acuminate pale rose-colored petals: in our plant the petals are oblong-lanceolate and obtuse.

17. E. TEXENSIS, Hopf. (E. Lindheimeri, *E. in Pl. Lindh.* 1845):

depressus; costis 13–27 acutis undulatis; areolis cordatis; aculeis robustis annulatis, plus minus curvatis rubellis, radialibus 6–7 infimo deficiente, centrali singulo robustiore compresso decurvato; floribus roseis dense lanatis; petalis laciniatis aristatis; bacca coccinea lanata; seminibus lævibus lucidis.

Southern Texas, and Northeastern Mexico, from the Colorado to Saltillo; not westward beyond the San Pedro River: fl. April and May. — Heads 8–12 inches in diameter, flat, or very old ones sometimes globose; spines from ½–2 inches long. Flowers about 2 inches long.

§ 3. *Theloidei*, Salm.

18. E. BICOLOR, Gal., var. SCHOTTII, E. in B. C. R.: ovatus; costis 8 obtusis interruptis; aculeis radialibus 15–17 rectis, summis 2–4 longioribus latioribus compressis, centralibus 4, summo latiore longiore; floribus majoribus purpureis.

Mier, on the Rio Grande: fl. September. — Plant 4–6 inches high, 2–3 in diameter; upper radial spines about 1 inch, upper central one 1½ inches long; lower radial and central spines reddish variegated. Flower 2–3 inches long, bright purple or rose-colored. — Distinguished from the Mexican *E. bicolor*, principally by the larger number of radial spines, and the greater length of the upper central spine, which is carinate underneath.

§ 4. *Intertexti.*

19. E. INTERTEXTUS, E. in B. C. R.: minor, ovato-globosus; costis 13 acutis interruptis; tuberculis sulcatis; aculeis rigidis rubellis apice fuscatis, radialibus 16–25 arcte adpressis, superioribus 5–9 tenuioribus subfasciculatis, infimo robusto brevi; centralibus 4, superioribus 3 radiales superiores excedentibus cum iis implicatis, inferiore singulo abbreviato porrecto; floribus parvis in vertice dense lanato congestis roseis; bacca vix squamata sicca; seminibus lucidis scaphoideis.

Var. β. DASYACANTHUS, E. l. c.: ovatus; aculeis setaceis longioribus purpureo-cæsiis, radialibus patulis, centrali inferiore ceteris paullo breviore.

From El Paso to the Limpio, and southward to Chihuahua: var. β. more common about El Paso: fl. March and April. — Plant 1 to 4, the var. β. even 6 inches high, 1–3 in diameter; spines 2–6, central ones 1–9 lines long, in β. 6–8 and central spines 9–11 lines long. Flower about 1 inch long. Fruit 4 lines in diameter.

E. UNGUISPINUS, E. in Wisl. Rep., from the country between Chihuahua and Parras, belongs here. The fruit described as belonging to this species is that of *E. uncinatus.*

Subtrib. 2. CONTRARIRÆ. Cotyledones facie hilum versus spectantes, lateribus seminis parallelæ.

III. CEREUS, Haw.

Ovarium baccaque sepalis squamiformibus in axillis plerumque pulvilligeris stipatæ. Stamina tubo floris breviori seu elongato infundibuliformi gradatim adnata. Semina fere exalbuminosa. Cotyledones abbreviatæ seu foliaceæ, plerumque hamatæ. — Plantæ costatæ, inflorescentia laterali.

Subgen. 1. ECHINOCEREUS, E. in Wisl. Rep.: ovarium aculeolatum: tubus floris abbreviatus, subcampanulatus: stigmata crassa viridia: semina tuberculosa: cotyledones suberectæ. — Plantæ humiles, sæpe subglobosæ, e basi ramosæ vel ramosissimæ.

§ 1. *Pectinati*, multicostati; areolis confertissimis plerumque elongatis, aculeis rigidis brevibus pectinatis.

* *Viridiflori.*

1. C. VIRIDIFLORUS, E. in Wisl. Rep.: ovatus seu demum cylindricus, simplex vel parce ramosus; costis sub-13; areolis ovato-lanceolatis; aculeis arcte radiantibus 12 – 18 cum superioribus 2 – 6 setaceis, lateralibus cæteris longioribus, inferioribus plerumque purpureo-fuscis, cæteris albidis, centrali plerumque nullo, subinde singulo robustiore variegato; floribus versus apicem lateralibus e flavo virescentibus minoribus; baccis ellipticis parvis; seminibus tuberculatis.

Var. *α.* MINOR: subglobosus; aculeis gracilibus brevibus.

Var. *β.* CYLINDRICUS: major, elongatus; aculeis rigidioribus longioribus.

Throughout Western Texas and New Mexico. Var. *α.* about Santa Fé and northeastward: *β.* east of El Paso. Fl. May and June. — The small form is 1 – 2 inches high, with spines rarely more than 2 lines long: the larger form, *β.* is 3 – 6 or more inches high, its spines 2 – 5 or 6 lines long: central spines, when present, longer and stouter. Flower about 1 inch long.

2. C. CHLORANTHUS, E. in B. C. R.: cylindricus, simplex, seu parce ramosus; costis 13 – 18; areolis ovatis; aculeis laxe radiantibus 12 –

20 cum superioribus 5 – 10 setaceis plerumque albidis; centralium 3 – 5 superioribus 2 brevioribus purpurascentibus, inferioribus 1 – 3 longioribus deflexis albidis; floribus in caule inferiore lateralibus e flavo virescentibus minoribus; baccis parvis; seminibus tuberculato-scrobiculatis.

Common about El Paso: fl. April. — Stems 3 – 10 inches high, 1½ – 2 inches in diameter; radial spines 2 – 5, central ones 9 – 15, lines long. Flowers very similar to those of the last species, but seeds different.

* * *Flaviflori.*

3. C. DASYACANTHUS, E. in Wisl. Rep.: subcylindricus, simplex vel e basi ramosus; costis 16 – 21; areolis ovatis; aculeis 20 – 30 patulis cinereis apice sæpe rubellis, interioribus 3 – 8 paullo robustioribus deflexis; floribus subterminalibus magnis; bacca subglobosa; seminibus tuberculatis.

Var. β. MINOR: aculeis paucioribus; bacca minore.

Common about El Paso: fl. April. — Plant 5 – 12 inches high, densely covered with numberless spines. Flowers 3 inches wide, yellow, an uncommon color in *Cerei.* Fruit an inch in diameter; in var. β. only half as large.

4. C. CTENOIDES, E. in B. C. R.: subsimplex, ovatus, 15-costatus; areolis lanceolatis; aculeis albidis, radialibus 14 – 20 pectinatis, centralibus 2 – 3 uniseriatis brevibus; floribus magnis.

Eagle Pass on the Rio Grande: fl. June. — Plant 2 – 4 inches high, thick in proportion; spines 1 – 4 lines long. Flower large. — Similar to the last, but distinguished by the characters given, which, with the exception of the yellow flower, bring it close to *C. pectinatus.*

* * * *Rubriflori.*

5. C. PECTINATUS, E. (Echinocactus pectinatus, *Scheid.*): ovato-cylindricus, 18 – 23-costatus; areolis lanceolatis; aculeis radialibus 16 – 20 subrecurvis pectinatis apice roseis, centralibus 2 – 5 brevissimis uniseriatis; tubo floris purpurei pulvillis 60 – 70 aculeolos rigidos 10 – 15 gerentibus stipato.

Var. β.? ARMATUS, Poselg.: costis 15 – 16; aculeis radialibus 16 – 20, centrali singulo cæteris longiore.

Var. γ.? RIGIDISSIMUS, E. in B. C. R.: costis 20 – 22; aculeis e basi bulbosa subulatis rigidissimis albidis seu rubellis 15 – 22 centralibus nullis; florum subverticalium tubo pulvillis 80 – 100 dense stipato.

South of the Rio Grande, Chihuahua, &c. — The var. β. from Monterey may belong either here or to the next species. The var. γ. from Sonora, without any central spines, and with very rigid radial ones, 1 – 4½ lines long, is not yet sufficiently known to decide about its affinities.

6. C. CÆSPITOSUS, E. in Pl. Lindh. 1845: ovato-cylindricus, 12 – 18-costatus; areolis lanceolatis; aculeis radialibus 20 – 30 rectis seu subrecurvis pectinatis albidis, centrali nullo vel raro, uno alterove brevissimo; tubo floris purpurei pulvillis 80 – 100 aculeolos capillares 6 – 12 obscuros lanamque longam cineream gerentibus dense stipato.

Var. α. MINOR: aculeis brevioribus gracilioribus non intertextis; floribus minoribus.

Var. β. MAJOR: aculeis longioribus robustioribus intertextis; floribus majoribus.

Var. γ. CASTANEUS: aculeis rubellis seu castaneis.

From the Canadian near Delaware Mount, to the Rio Grande, and south to Monterey; west not farther than the San Pedro River: fl. in May and June. — This species, now not rare in cultivation, seems to be sufficiently distinct from the preceding, and may always be recognized by the characters indicated.

7. ? C. ADUSTUS, E. in Wisl. Rep.: ovatus, 13 – 15 costatus; areolis ovatis seu ovato-lanceolatis; aculeis radialibus 16 – 20 adpressis albidis apice adustis, lateralibus inferioribusque longioribus, summis setaceis brevissimis, centrali nullo seu valido porrecto atrofusco.

Mountains west of Chihuahua: flower and fruit unknown. — *Echinocereus radians*, E. is the form with stout central spines.

8. ? C. RUFISPINUS, E. l. c.: ovato-cylindricus, 11-costatus; areolis lanceolatis; aculeis radialibus 16 – 18 adpressis intertextis, lateralibus cæteris multo longioribus fuscis recurvatis, centrali singulo valido fusco porrecto; flore infundibuliformi, tubo subelongato, limbo patulo; stigmatibus 8 tenuibus albidis.

Mountains west of Chihuahua: fl. in May. — Stem four inches high: radial spines 4 – 9 lines, central one about an inch, long. Flower different from that of all other *Echinocerei* in the length of the tube (over 2 inches long, and half as wide) and the whitish stigmata. Seems to form a transition to other sections of the genus.

9. ? C. LONGISETUS, E. in B. C. R.: subsimplex, ovato-cylindricus; costis 11 – 14 tuberculatis; areolis orbiculatis; aculeis setaceis albis,

radialibus 18 – 20, centralibus 5 – 7, quorum 3 inferiores elongati deflexi.

Santa Rosa, south of the Rio Grande. — Stem 6 – 9 inches high; tubercles well marked; lower radial spines 5 – 7 lines long, much longer than the upper ones; lower central spines 1 – 2 inches long. Flower said to be red.

§ 2. *Decalophi.*

* *Purpurei; floribus diurnis.*

10. C. Fendleri, E. in Pl. Fendl.: ovato-cylindricus; costis 9 – 12; areolis subconfertis; aculeis basi bulbosis, radialibus 7 – 10 rectis seu curvatis albidis et fuscis, inferioribus robustioribus, centrali valido sursum curvato atrofusco plerumque elongato; floribus sub vertice lateralibus magnis; seminibus obliquis tuberculato-scrobiculatis.

New Mexico, from Santa Fé to below El Paso, and from east of the Pecos to Zuni: fl. in May and June. — Stems 3 – 8 inches high, not many from the same base; spines very variable, but always very bulbous at the base, and some of them white, some deep brown or black, and others party-colored; radial ones ½ – 1 inch, and the central one 1 – 2 inches long. Flower 2½ – 3½ inches in diameter, of a deep purple color. Berry 1 – 1¼ inch long, edible. Seed deeply and irregularly pitted by the confluence of many of the tubercles, unusually oblique.

11. ? C. Mojavensis, E. & B. in P. R. R.: ovatus, dense cæspitosus, glaucescens, 10 – 12 costatus; areolis remotis; aculeis validis curvatis, radialibus 7 – 8, lateralibus robustioribus longioribus, centrali singulo sursum curvato elongato.

Var. β. ? Zuniensis: 10-costatus; aculeis debilioribus 4-angulatis bulbosis rectis vel flexuosis, radialibus 8, summo longiore robustiore; centrali recto seu sursum curvato longiore, omnibus bulbosis.

On the Mojave River in California, and β. farther east, on the Colorado Chiquito. Ovate heads 2 – 3 inches high, forming dense cæspitose masses; upper and lower spines 9 – 15 lines, lateral ones 15 – 25 lines long, central spine 1½ – 2½ inches long, dusky. Var. β. is distinguished by having the upper radial spine almost as stout and long as the central spine, the former being 12 – 18, the latter 18 – 24 lines long. Both seem to be distinguished from the nearly allied *C. Fendleri* by having the lowest spines weakest, while in that species they are the stoutest of the exterior ones. The resemblance to *C.*

Fendleri induces me to place this species here, though the flower remains unknown.

12. C. ENNEACANTHUS, E. in Wisl. Rep.: ovato-cylindricus, viridis, cæspitosus, 7–10 costatis; aculeis rectis, radialibus 7–12 (plerumque sub-8) albis, inferioribus longioribus; centrali singulo (rarius 2–3) basi bulboso teretiusculo seu compresso angulato albido vel stramineo; ovario pulvillis 25–35 aculeolos 6–12 gerentibus stipato; seminibus tuberculatis.

In the Rio Grande valley from El Paso to Laredo, and lower down, and far into Mexico: fl. April and May. — A very cæspitose plant, of a wrinkled or withered appearance; 3–6 inches high; spines above 3–5, below 8–16 lines long; lateral ones intermediate; central spine extremely variable, in smaller specimens terete, in very perfect ones elongated, flattened, 8 or 10–15 or 20 lines long. Flowers 2–3 inches long and equally wide: ovary and tube covered with numerous bunches of spines. Fruit about an inch long, edible.

13. C. STRAMINEUS, E. in B. C. R.: ovato-cylindricus, cæspitoso-conglomeratus, 11–13-costatus, læte viridis; aculeis radialibus 7–10 rectis vel curvatis albis subæqualibus, centralibus 3–4 angulatis elongatis sæpe flexuosis; floribus magnis purpureis; ovario pulvillis 30–40 aculeolos subsingulos gerentibus stipato; bacca magna fasciculis aculeolorum elongatorum stipata; seminibus tuberculatis.

Mountain slopes, from El Paso to the Pecos and Gila Rivers: fl. June. Often from 100 to 200 heads in one hemispherical mass, each 5–9 inches high; radial spines mostly 8, ¾–1¼, central ones 2–3½ inches long, younger ones dirty yellow and brown, like old straw. Flower 3–4 inches long, very full, bright purple. Berry 1½–2 inches long, luscious.

14. C. DUBIUS, E. in B. C. R.: ovato-cylindricus, cæspitosus, pallide viridis, 7–9 costatus; aculeis radialibus 5–8 albidis, superioribus sæpe nullis, centralibus 1–4 angulatis plus minus elongatis sæpe curvatis; floribus pallide purpureis; ovario pulvillis sub-20 aculeolos 1–2 gerentibus stipato; bacca minore aculeolata; seminibus tuberculato-scrobiculatis.

Sandy bottoms of the Rio Grande at El Paso: fl. May and June. Stems 5–8 inches high, somewhat cæspitose, of a pale green color, and a soft flabby texture: ribs broad, fewer; radial spines 6–12 or 15 lines long; central spines 1½–3 inches long, flowers 2½ inches long, with fewer and narrower petals. Fruit 1–1½ inches long, covered with bunches of spines which, as in the last species, on the flower are indicated only by few and short bristles. Seed with tubercles confluent, and leaving pits between them. Nearly allied to the two last, but sufficiently well distinguished by the characters given.

15. C. ENGELMANNI, Parry in Sill. Journ. 1852: ovato-cylindricus, 11 – 13 costatus; aculeis radialibus sub-13 albidis, superioribus cæteris multo brevioribus, centralibus 4 longioribus angulatis rectis, 3 superioribus fulvis arrectis, inferiore longiore albido porrecto seu deflexo; floribus lateralibus; seminibus tuberculato-scrobiculatis.

Var. β. CHRYSOCENTRUS, E. & B. in P. R. R.: aculeis radialibus 12 – 14 albidis, centralibus 3 superioribus validis vitellinis erectis, inferiore albo compresso deflexo.

Var. γ. VARIEGATUS, E. & B. l. c.: aculeis radialibus sub-13 albidis, centralibus 3 superioribus recurvatis divaricatis nigris corneo-variegatis, inferiore longiore albo decurvo.

Lower Gila, Colorado, and westward to the California mountains: fl. June and July. — Stems 5 – 10 inches high; radial spines slender, 3 – 6 lines, central ones 1 – 2 inches long. Fruit near the top of the plant. — Dr. Bigelow collected a little farther north, on Bill Williams's Fork, the two forms which I have put under β. and γ.; though they differ from the species by having the fruit lower down on the plant; the arrangement of the spines, however, is entirely identical. Var. β. has very stout central spines, 2 – 3 inches long, of a deep golden-yellow color, and the lower one shorter. In var. γ. the central spines are only 1 – 2 inches long, much curved, and the upper ones white and black mottled.

* * *Coccinei; floribus diu noctuque apertis.*

16. ? C. GONACANTHUS, E. & B. in P. R. R.: ovatus, subsimplex, 7-costatus; areolis remotis; aculeis robustis angulatis sæpe curvatis, radialibus 8 flavidis sæpe basi obscuris, summo cæteris multo majore centralem multangulatum validum sæpe flexuosum subæquante.

Near Zuni, in Western New Mexico, under cedars. — Radial spines 8 – 15 lines long, upper one and central spine 1¼ – 2½ inches long, remarkably stout, angular and channelled. — I have not seen the flower of this plant, but place it here from its resemblance to the next species; on the other hand, it seems to be allied to *C. Mojavensis.*

17. C. TRIGLOCHIDIATUS, E. in Wisl. Rep.: ovato-cylindricus, 6 – 7 costatus, parce ramosus; areolis remotis; aculeis 3 – 6 robustis an-

gulatis compressis rectis seu curvatis laxe radiantibus; floris coccinei staminibus petala obtusa subæquantibus; stigmatibus 8 – 10.

Northern New Mexico, at Santa Fé, and to the east and westward: fl. June. — Stems 4 – 6 inches high, 2 – 3 in diameter, with sharp ridges and very shallow grooves; spines 6 – 15 lines long. Flower 2 – 3 inches long; petals rigid. Fruit unknown.

18. C. PHŒNICEUS, E. in P. R. R. (C. coccineus, *E. in Wisl. Rep. non Salm.*): ovatus seu subglobosus, obtusus, cæspitosus, 9 – 11-costatus; areolis ovato-orbiculatis subconfertis; aculeis setaceis rectis, radialibus 8 – 12 albidis, superioribus cæteris paullo brevioribus, centralibus 1 – 3 basi bulbosis teretibus paullo robustioribus; staminibus petalis brevioribus; stigmatibus 6 – 8.

Northern New Mexico, from the Upper Pecos to Santa Fé, Zuni, and the San Francisco mountains: fl. May and June. — Heads 2 – 3 inches high, 2 inches thick, generally forming dense hemispherical masses, often of a foot or more in diameter; radial spines 3 – 6, central ones 5 – 10 lines long. When there are several, the lowest one longest. Fruit unknown.

C. CONOIDEUS, E. & B. l. c.: ovatus, versus apicem acutatus, conoideus, e basi parce ramosus 9 – 11 costatus; aculeis radialibus 10 – 12 gracilibus rigidis, summis brevioribus, centralium 3 – 5 infimo 4-angulato elongato demum deflexo.

Rocky places on the Upper Pecos, and perhaps San Francisco mountains. — Heads 3 – 4 inches high, few, of unequal height from one base; upper radial spines 2 – 5 lines, lateral ones 6 – 15 lines long; upper central spines hardly longer than the lateral ones; lower one 1 – 3 inches long, angular and often compressed. The Mexican *C. acifer*, Otto, seems similar, but is a higher plant, with much stouter spines. *C. Rœmeri*, Muhlenpf. A. G. Z. 1848, from Western Texas, may belong here or to *C. enneacanthus*. A specimen among Dr. Bigelow's collections seems to unite this form with *C. phœniceus*, where for the present it is perhaps best to leave our plant, as a variety or sub-species.

19. C. POLYACANTHUS, E. in Wisl. Rep.: ovato-cylindricus, cæspitosus, subglaucescens, 9 – 13 costatus; aculeis robustis rigidis rectis albidis seu rubello-cinereis, centralibus 3 – 4 bulbosio paullo robustioribus æquilongis seu longioribus, junioribus sæpe fusco-variegatis; stigmatibus 8.

Common about El Paso, and thence to the mountains of Chihuahua:

fl. March and April. — Heads 5 – 10 inches high, $2\frac{1}{2}$ – 4 in diameter; upper radial spines $\frac{1}{2}$, lateral and lower ones $\frac{3}{4}$ – 1 inch long; central spines hardly longer, or the lower sometimes $1\frac{1}{2}$ – $2\frac{1}{2}$ inches long. Flowers 2 – 3 inches long, profusely covering the plant for four or six weeks. Seed the largest of any *Echinocerei* known to me, 0.8 – 0.9 of a line long.

20. C. Rœmeri, E. in Pl. Lindh. 1850: ovatus, cæspitosus, læte viridis; costis 7 – 9 tuberculatis interruptis; areolis orbiculatis, junioribus breviter tomentosis; aculeis teretibus robustis albidis seu junioribus flavidulis demum cinereis, radialibus sub-8, centrali singulo robustiore porrecto; floribus lateralibus infundibuliformibus limbo erectiusculo; pulvillis ovarii tubique 16 – 18 albo-tomentosis aculeolos 3 – 5 gerentibus; sepalis interioribus 7 – 8 ovato-oblongis carinatis obtusis mucronatis; petalis 9 – 12 obovato-spathulatis obtusis integris concavis rigidis suberectis; stylo longe supra stamina albida sursum rosea exserto; stigmatibus 6 – 7 petala æquantibus erecto-patulis viridibus acutiusculis.

In the granitic region about the Llano River, Western Texas: fl. May: fruit unknown. — Often 5 – 12 from the same base, densely cæspitose; single heads 3 – 4 inches high, 2 – $2\frac{1}{2}$ in diameter; areolæ 6 – 8 lines apart; radial spines 5 – 12 lines long, upper ones usually a little shorter than the rest; central spine 10 – 15 lines long. Flower 2 inches long and only one in diameter, remaining open day and night for a whole week, if the weather is not too warm. — Allied to the last species; but distinct by the shorter heads, fewer ribs, fewer and paler spines, and smaller flower, with less numerous parts.

21. ? C. paucispinus, E. in B. C. R.: ovato-cylindricus, parce ramosus vel simplex, 5 – 7-costatus; areolis remotis; aculeis robustis 3 – 6 radiantibus fuscatis, centrali nullo vel raro robusto subangulato.

Western Texas, from the San Pedro to the mouth of the Pecos. — Stem 5 – 9 inches high, 2 – 3 in diameter; spines 9 – 16 lines long, dark-colored, the central one almost always wanting. Flower and fruit unknown.

22. ? C. hexaedrus, E. & B. in P. R. R.: ovatus subsimplex, 6-costatus; areolis remotis; aculeis rectis rigidis tenuibus angulatis, radialibus 5 – 7 flavo-rubellis, inferiore breviore, centrali paullo robustiore (juniore fuscato) sæpe deficiente.

Near Zuni, in Western New Mexico. — Heads few in each plant, or single, 4 – 6 inches high, 2 – $2\frac{1}{2}$ inches in diameter. Radial spines

mostly 6 lines, lower ones 6 – 10 lines, upper ones 8 – 15 lines long; central spine, if present, 12 – 15 lines long.

§ 3. *Pentalophi.*

23. C. Berlandieri, E. in B. C. R.: humilis, perviridis; caule diffuso subtereti articulato ramosissimo; tuberculis conicis 5 – 6-fariis; aculeis 6 – 8 setaceis brevibus radiantibus albidis, centrali singulo multo longiore fusco; floribus magnis; petalis angustis recurvatis; seminibus tuberculatis.

On the Nueces, in Southern Texas: fl. May and June. — Stems 1½ – 6 inches long, one inch thick; radial spines 4 – 5 lines long, central one 6 – 12 lines long, toward the base of the branches shorter. Flower 2 – 4 inches long.

24. C. procumbens, E. in Pl. Lindh. 1850: humilis, perviridis; caule diffuso subtereti 4 – 5 angulato articulato ramosissimo; aculeis 4 – 6 radiantibus albidis, centrali nullo vel singulo paullo longiore obscuro; floribus magnis; petalis obovato-spathulatis patulis seu subrecurvis; seminibus tenuissime verrucosis.

On the Rio Grande, below Matamoras: fl. May and June. — Similar to the last; but more slender, 6 – 8 lines in diameter; radial spines 1 – 2 lines long, central one, if present, 2 – 3 lines long. Flower above 3 inches long.

§ 4. *Graciles.*

25. C. tuberosus, Poselger: e radice tuberosa tenuissimus, teres, sursum incrassatus, demum articulatus, 8-costatus; aculeis minutis setaceis, 9 – 12 radiantibus, centrali singulo longiore sursum adpresso; flore subterminali; seminibus minutis scrobiculatis.

Between Laredo and Mier on the Rio Grande. Tuberous root ½ – 1½ inches thick. Stem above 4 – 8 lines thick; radial spines hardly 1 line, central ones 2 – 3 lines long. Seed smaller than in any other *Echinocereus*, 0.4 line long, with the tubercles confluent.

Subgen. 2. Eucereus. Caulis elongatus: fasciculi aculeorum steriles et florigeri similes: floris tubus elongatus, sæpissime aculeolis capillaceis munitus: stigmata pallida: semina lævia seu raro rugosa: embryo hamatus.

26. C. Emoryi, E. in Sill. Journ. 1852: prostratus; ramis adscendentibus 15-costatis; areolis confertis; aculeis setaceis rigidis flavis,

radialibus 40 – 50 stellatis, centrali unico longiore robustiore; flore flavo breviusculo; bacca aculeatissima; seminibus magnis lucidis.

On hills near San Diego, California, growing in thick patches. — Stems several feet long; branches 6 – 9 inches high, 1½ inches in diameter. Fruit very spinose, with seeds over one line in length.

27. C. VARIABILIS, Pfeiff.: erectus, 3 – 4 angulatus; areolis remotis; aculeis 4 – 6 brevibus radiantibus, 2 – 4 interioribus validis elongatis inæqualibus divaricatis, centrali deflexo; flore magno albo nocturno; bacca coccinea aculeolata; seminibus magnis lævibus.

On the lower Rio Grande: fl. in May and June. — Well known from all parts of tropical America. Fruit 3 to 10 feet high, 2 inches in diameter; larger spines 12 – 18 lines long. Fruit 2 – 3 inches long, nearly 2 inches in diameter.

28. C. GREGGII, E. in Wisl. Rep.: gracilis, e radice crassa napiformi erectus; ramis 3 – 6-angulatis, rufescentibus; areolis confertis; aculeis e basi bulbosa abrupte subulatis brevissimis nigricantibus, radialibus 6 – 9, centralibus 1 – 2; floris elongati albidi tubo aculeolis capillaceis flexuosis munito; bacca sessili obovata apice rostrata; seminibus rugosis.

Var. *α.* CISMONTANUS: areolis elongatis; petalis latioribus.

Var. *β.* TRANSMONTANUS: areolis ovato-orbiculatis; petalis angustioribus.

From Western Texas to Sonora, and south to Chihuahua: fl. May and June. — Root a large fleshy tuber, sometimes 6 inches in diameter. Stems 2 – 3 feet high, 9 – 12 lines thick, usually 4- or 5-angled; spines ½ – 1 line long, very sharp; lower ones longer. Flower 6 or 8 inches long, 2 – 2½ wide. Fruit 1 – 1½ inches long. Seed 1¼ – 1½ lines long.

Subgen. 3. LEPIDOCEREUS. Caulis elongatus: fasciculi aculeorum steriles et florigeri similes: floris tubus brevior squamosus: phylla numerosissima: stigmata pallida: semina lævia: embryo hamatus.

29. C. GIGANTEUS, E. in Emory's Rep. 1848: erectus, elatus, parce erecto-ramosus, 18 – 21-costatus; aculeis 12 – 16 radialibus inæqualibus, centralibus sub-6 robustis basi bulbosis corneis basi nigris cæteros superantibus, infimo longiore deflexo; floribus subterminalibus albidis; bacca obovata demum 3 – 4-valvi.

From the Lower Gila north to Williams's River (better known

among western travellers as Bill Williams's Fork), and south into Sonora: fl. May – July; fr. July and August. — A now well-known plant to travellers and botanists, 30 – 50 feet high, 1 – 2 feet in diameter; central spines 1½ – 2½ inches long. The yellowish-white flower 3 – 4 inches long. Fruit 2 – 3 inches long, often pear-shaped, and opening with 3 or 4 irregular recurved valves.

30. C. THURBERI, E. in Sill. Journ. 1854: caulibus erectis vel adscendentibus pluribus elatioribus articulatis 13 – 14-costatis; aculeis 7 – 15 gracilibus fusco-atris valde inæqualibus; ovario tuboque imbricato-squamato; bacca globosa magna.

Sonora, west of the Sierra Madre: fl. June and July. — Stems 5 – 15 from one root, 10 – 15 feet high, 4 – 6 inches in diameter; spines slender, flexible, from 5 – 18 lines long. Flowers 3 inches long, white. Fruit like a large orange, of delicious flavor.

Subgen 4. PILOCEREUS. Caulis elatus: fasciculi aculeorum steriles a floriferis tenuioribus longioribus distincti: floris tubus brevis squamosus: phylla pauciora: stigmata pallida: semina lævia: embryo hamatus (in specie nostra!).

31. C. SCHOTTII, E. in B. C. R.: caulibus erectis vel adscendentibus pluribus elatioribus articulatis 4 – 7-costatis; areolis in articulis sterilibus remotis; aculeis brevibus robustis, radialibus 4 – 6, centrali unico; areolis in articulis floriferis confertis; aculeis 15 – 25 longioribus setaceis flexuosis e rubello cinereis; floribus carneis minoribus, tubo gracili decurvo; bacca parva.

Sonora, towards Santa Magdalena: fl. July. Stems 8 – 10 from the same base, often growing in dense clusters, 8 or 10 feet high, with 2 – 4 articulations, 4 or 5 inches in diameter. Spines of the sterile part of the plant 3 – 4 lines long, on the fertile joints 1 – 4 inches long, pendulous, forming a reddish-gray beard, in which the flower (not 2 inches long) is somewhat hidden. Seeds large: cotyledons hooked, exactly as in the last two species. This is evidently a *Pilocereus*, but with the seed of a true *Cereus*, thus reuniting the former with the latter.

Trib. II. ROTATÆ, Miquel.

Aphyllæ seu foliosæ. Flores tubo abbreviato subrotati. Cotyledones facie versus hilum spectantes seminis lateri contrariæ (incumbentes).

IV. OPUNTIA, Tourn.

Ovarium sepalis subulatis caducis axillâ pulvilligeris instructum. Semina magna, compressa, discoidea, sæpe marginata, albida. Cotyledones foliaceæ, circa albumen curvatæ, plerumque incumbentes. — Plantæ articulatæ; articulis complanatis seu teretibus plus minus tuberculatis; foliis subulatis caducis axillâ pulvillos setosos plerumque aculeiferos gerentibus; aculeis apice retrorsum hispidis.

ANALYSIS.

I. Petala parva, subulata, suberecta.	Subgen. 1. STENOPUNTIA.
II. Petala lata, obovata seu obcordata.	
1. Articuli complanati: embryo circa albumen parcum spiraliter convolutus.	Subgen. 2. PLATOPUNTIA.
A. Bacca succosa: margo seminum plerumque angustior (*Sarcocarpeæ*).	
a. Glabræ.	
* Bacca parva subglobosa.	§ 1. *Microcarpeæ.*
* * Articuli magni: aculei pauci compressi.	§ 2. *Grandes.*
* * * Articuli minores: aculei setiformes.	§ 3. *Setispinæ.*
* * * * Articuli minores: aculei pauci, robusti, teretes.	§ 4. *Vulgares.*
b. Pubescentes.	§ 5. *Pubescentes.*
B. Bacca sicca: margo seminum plerumque latissimus.	§ 6. *Xerocarpeæ.*
2. Articuli cylindracei: embryo circa albumen copiosius subcircularis.	Subgen. 3. CYLINDROPUNTIA.
A. Articuli abbreviati, clavati.	§ 1. *Clavatæ.*
B. Articuli cylindracei, elongati.	§ 2. *Cylindricæ.*

Subgen. 1. STENOPUNTIA, E. in B. C. R. Articuli complanati: flores parvi: petala subulata: stigmata pauca.

1. O. STENOPETALA, E. l. c.: prostrata; articulis magnis; aculeis 1–3 cum minoribus 1–3 ancipitibus deflexis atrofuscis; ovario pulvillis confertis stipato; sepalis petalisque subulatis suberectis; stylo inflato; stigmate simplici.

On the battle-field of Buena Vista, south of Saltillo. Nearly allied to the Mexican *O. grandis*, Hort. Angl., which has very similar flowers, but is an erect plant, with few and white spines, and 2 or 3 acute stigmata.

Subgen. 2. PLATOPUNTIA, E. l. c. Articuli complanati: flores magni: bacca pulposa vel rarius sicca: semina late marginata: embryo plusquam circularis circa albumen parcum spiraliter convolutus: cotyledones semper contrariæ.

§ 1. *Microcarpeæ:* suberectæ: aculei plurimi, colorati: bacca parva subglobosa.

2. O. STRIGIL, E. in B. C. R.: suberecta, articulis ovatis orbiculatisve; pulvillis confertis; aculeis 5–8 radiantibus deflexis rufis apice flavis; bacca parva late umbilicata rubra; seminibus parvis anguste marginatis.

Between the Pecos and El Paso. — Plant 2 feet high; joints 4–5 inches long; spines an inch or less in length. Fruit 6–7 lines long.

§ 2. *Grandes:* erectæ seu procumbentes: articuli magni: aculei pauci, validi, compressi, plerumque colorati: bacca major vel magna, plerumque ovata.

* *Subinermes.*

3. O. FICUS-INDICA, Mill: cultivated south of the Rio Grande, under the name *Nopal Castillano.*

* * *Flavispinæ.*

† *Erectæ.*

4. O. TUNA, Mill: cultivated about the old missions in the southern parts of Upper California, under the name *Tuña.* Specimens gathered at Beaufort, on the coast of South Carolina, (probably introduced,) may belong here.

5. O. ENGELMANNI, Salm: erecta, grandis; articulis obovatis; pulvillis remotis setas stramineas rigidas inæquales aculeosque 1–3 compressos stramineos basi rufos gerentibus; floris flavi intus rubelli ovario subgloboso; stigmatibus 8–10; bacca obovata late umbilicata; seminibus minoribus.

From the Canadian River to the mouth of the Rio Grande, and westward from the Gulf to Chihuahua and El Paso: fl. May and June. — Plant 4–6 feet high; joints a foot long or less; leaves subulate, 3–4 lines long; larger spines 1–1½ inches long. Flower 2½–3 inches in diameter. Fruit usually 2 inches long, 1½ in diameter, juicy, but of a somewhat nauseous taste. Seeds 1½–2 lines in diameter. A plant observed by Dr. Blackie on Bayou Bœuf, Western Louisiana, 5½ feet high, joints 9 inches long, reddish-yellow flowers, is probably this species.

O. Lindheimeri, E. Pl. Lindh., is partly this same plant, partly a hybrid form between it and perhaps *O. Rafinesquii*, with narrow clavate fruit.

O. ENGELMANNI, var.? CYCLODES, E. & B. in P. R. R.: articulis orbiculatis; aculeis validioribus subsingulis; bacca parva globosa; seminibus majoribus.

On the Upper Pecos, in New Mexico. Joints 6–7 inches, and fruit 1 or 1¼ inches in diameter.

O. DULCIS, E. in B. C. R., is a doubtful plant, of which we have not material enough. It has been found near the middle course of the Rio Grande, near Presidio del Norte, &c. It is similar to *O. Engelmanni*, and may be a form of it; but it is lower, more spreading, with a similar but very sweet fruit, and small, regular seeds.

The following may be considered as a subspecies: —

O. OCCIDENTALIS, E. & B. in P. R. R.: erecta, patulo-ramosissima; articulis grandibus obovatis vel rhomboideis; pulvillis remotis setas graciles confertas et aculeos 1–3 validos compressos deflexos albidos basi obscuriores et inferiores paucos graciliores gerentibus; floris flavi intus rubelli ovario obovato; bacca obovata late umbilicata; seminibus majoribus.

On the western slope of the California mountains, near San Diego and Los Angeles: fl. June. — Plant 4 feet high, forming large thickets; the joints 9–12 inches long; pulvilli with very fine closely-set bristles; spines about one inch long. Apparently distinct from *O. Engelmanni* by its manner of growth, the very fine bristles, and the larger seeds.

There are also some indications of another form, growing on hills and plains near San Diego, California, and on the neighboring sea-beach, with higher and more upright growth, and coarser bristles on the pulvilli, but which I cannot well distinguish from *O. Engelmanni*. I have seen no fruit or seed of it.

6. O. CHLOROTICA, E. & B. in P. R. R.: caule erecto aculeis flavis numerosissimis fasciculatis armato; articulis orbiculato-obovatis pallidis; pulvillis subremotis setas difformes confertas aculeosque 3–6 inæquales compressos stramineos gerentibus; floris flavi ovario pulvillis confertis stipato; petalis spathulatis.

Western Colorado country, between New Mexico and California, from the San Francisco mountains to Mojave Creek. — Plant 4–6 feet high, forming large and sometimes spreading bushes; the trunk

covered with spines 1 – 2 inches long; joints 8 – 10 by 6 – 8 inches in length; spines ½ – 1½ inches long. Ovary with nearly 50 pulvilli, while the foregoing species have not more than 20.

†† *Procumbentes.*

7. O. PROCUMBENS, E. & B. l. c.: prostrata; articulis orbiculato-obovatis grandibus pallide viridibus; pulvillis remotis setas stramineas rigidas valde inæquales et aculeos 2 – 4 validos compressos angulatos stramineos basi obscuriores gerentibus.

San Francisco mountains to Cactus Pass, in Western New Mexico. Joints 9 – 13 inches long, always edgewise; pulvilli 1½ – 2 inches apart; spines 1 – 2 inches long. Similar to *O. Engelmanni*, but prostrate, with more distant pulvilli, and stouter spines. No flower or fruit seen.

8. O. ANGUSTATA, E. & B. l. c.: prostrata vel adscendens; articulis elongato-obovatis versus basin angustatis; pulvillis remotis setas fulvas graciles aculeosque paucos (2 – 3) validos compressos stramineos seu albidos versus basin rufos deflexos gerentibus; bacca obovata tuberculata; seminibus magnis.

From Zuni, west of the Rio Grande, westward to the Cajon Pass, in the California mountains. — Joints 6 – 10 inches long, only 3 or 4 wide. Spines similar to those of the last species; bristles much more delicate. Fruit 1½ inches long; the umbilicus flat, but immersed. — Well distinguished by the shape of the joints.

* * * *Fulvispinæ.*

9. O. MACROCENTRA, E. in B. C. R.: adscendens; articulis magnis suborbiculatis tenuibus; pulvillis subremotis setas graciles breves fulvas gerentibus, summis solum aculeos 1 – 2 prælongos subcompressos fusco-atros proferentibus; floris flavi ovario ovato; stigmatibus 8; seminibus majusculis.

Sand-hills on the Rio Grande near El Paso: fl. May. — Two or three feet high, with very striking round joints, 5 – 8 inches in diameter, and blackish spines as much as 2 or 3 inches long. Nearly allied to the next species.

10. O. PHÆACANTHA, E. in Pl. Fendl.: diffusa, adscendens; articulis obovatis crassis glaucescentibus; pulvillis subremotis setas graciles stramineas seu fuscatas longiores gerentibus, plerisque aculeos 2 – 5 p us minus compressos fuscos proferentibus; floris flavi ovario abbreviato; stigmatibus 8; bacca cuneata pyriformi; seminibus majusculis.

Var. *α.* NIGRICANS: aculeis brevioribus acute angulatis et nigricantibus.

Var. *β.* BRUNNEA: pulvillis remotioribus; aculeis longioribus obtuse angulatis brunneis sursum albidis.

Var. *γ.* MAJOR: suborbiculata; pulvillis remotis; aculeis brevioribus paucioribus pallidioribus.

New Mexico: fl. May. Var. *α.* is found on the Rio Grande near Santa Fé; *β.* in similar sandy locations near El Paso; and *γ.* in mountainous regions near Santa Fé. — Joints 4–6, or in *γ.* even 8, inches long; spines mostly 1–2 inches in length. Flower about 2 inches in diameter, with a short ovary. Fruit 1¼–1½ inches long, slender, much contracted at base so as to appear almost stipitate.

O. MOJAVENSIS, E. & B. in P. R. R.: prostrata; articulis grandibus suborbiculatis; pulvillis remotis; setis fulvis; aculeis 3–6 validis infra fuscis.

On the Mojave, west of the Colorado. — The material is too scanty to make out where it belongs; but perhaps it is only a form of *O. phæacantha.*

11. O. CAMANCHICA, E. & B. in P. R. R.: prostrata; articulis adscendentibus majusculis suborbiculatis; pulvillis remotis plerisque armatis; setis stramineis fulvisve parcis; aculeis 1–3 compressis fuscis apice pallidioribus, superioribus elongatis suberectis, cæteris deflexis; bacca ovata late umbilicata; seminibus majusculis angulatis hilo excisis.

Llano Estacado, on the Upper Canadian River. A large, extensively spreading plant; the joints 6–7 inches long; spines 1½–2 or even 3 inches long. Fruit large, juicy. Seeds 2–3 lines in diameter, very irregular and deeply notched at the hilum.

12. O. TORTISPINA, E. & B. l. c.: prostrata; articulis adscendentibus majusculis suborbiculatis; pulvillis subremotis; setis stramineis seu fulvis; aculeis 3–5 majoribus angulatis sæpe tortis albidis cum 2–4 gracilioribus; bacca ovata late umbilicata; seminibus majusculis orbiculatis.

On the Camanche plains, east of the elevated plateau of the Llano Estacado. — Similar in size and habit to the last species, its western neighbor, with more numerous spines than any other of our *Opuntiæ* with juicy fruit. Seeds regular, and only very slightly notched at the hilum.

§ 3. *Setispinæ:* adscendentes: articuli plerumque minores: aculei pauci, teretes seu vix angulati, graciles, flexiles, pallidi: bacca minor.

13. O. TENUISPINA, E. in B. C. R.: articulis majusculis obovatis basi attenuatis læte viridibus; pulvillis subapproximatis setas graciles breves fulvas gerentibus plerisque armatis; aculeis 1 – 2 elongatis albidis cum 1 – 4 brevioribus inferioribus; floris flavi ovario clavato; petalis obovatis retusis; bacca oblonga profunde umbilicata; seminibus minoribus.

Sand-hills near El Paso: fl. May. — Joints 3 – 6 inches long, 2 – 4 wide; leaves very slender, hardly 2 lines long; upper spines suberect, or spreading, 1½ – 2½ inches long; flower 2½ – 3 inches in diameter; seeds less than 2 lines in diameter, very irregular. — Similar in many respects to *O. phæacantha*, which grows with it; but readily distinguished by the spines and fruit.

14. O. SETISPINA, E. in Salm, H. D.: articulis suborbiculatis parvis glaucis; pulvillis confertis setas flavidas gerentibus, omnibus armatis; aculeis 1 – 3 longioribus subangulatis et 3 – 7 brevioribus plus minus deflexis, omnibus gracillimis.

Pine woods in the mountains west of Chihuahua, *Dr. Wislizenus.* Joints not over 2 inches long; pulvilli only 3 – 4 lines apart; longer spines 1 – 1½ inches long, very slender, like bristles. Flower and fruit unknown.

15. O. FILIPENDULA, E. in B. C. R.: glauca; radicibus nodoso-incrassatis; articulis minoribus orbiculatis seu obovatis seu oblanceolatis tenuibus; pulvillis approximatis setas virescenti-flavas graciles numerosas gerentibus armatis vel inermibus; aculeis, si adsunt, 1 – 2 elongatis subangulatis cum 1 – 2 minoribus, omnibus albidis; floris purpurascentis ovario gracili; stigmatibus 5; seminibus minoribus tumidis.

Alluvial bottoms of the Rio Grande near El Paso, and eastward on the Pecos: fl. May and June. — The long knotted roots, the small bluish joints, with the very small leaves and very long bristles, together with the purple flower, and thick very narrowly margined seeds, distinguish this species from all others. Plant 6 – 12 inches high, joints 1½ – 3 inches long, 1 – 2 wide; pulvilli 4 – 6 lines apart; lower spines 1 – 2 inches long. Flower 2½ inches in diameter. Seed hardly 2 lines in diameter.

§ 4. *Vulgares:* procumbentes vel adscendentes: articuli plerumque minores: aculei validi, subteretes vel nulli, albidi vel obscuriores: bacca clavata.

16. O. Rafinesquii, E. in P. R. R.: diffusa; radice fibrosa; articulis obovatis vel suborbiculatis perviridibus, foliis elongatis patulis; pulvillis subremotis setas graciles rufas gerentibus plerisque inermibus; aculeis paucis marginalibus validis rectis singulis erectis patulisve, uno alterove minore deflexo subinde adjecto, rufo variegatis; alabastro acuto; ovario clavato pulvillis 20–25 stipato; petalis 10–12; stigmatibus 7–8; bacca clavata.

Var. microsperma: subinermis: seminibus minoribus angustius marginatis.

Sterile, sandy, or rocky soil in the Mississippi valley, from Kentucky to Missouri, and from Minnesota southward: fl. May and June. — Joints 3–5 inches long; leaves 3–4 lines long; spines 9–12 lines long, sometimes entirely wanting. Flowers 2½–3½ inches in diameter, yellow, often with a red centre. Seed 2½ lines, or in the variety less than 2 lines in diameter. — This species had been confounded with the Eastern *O. vulgaris* by all our botanists, with the exception of Rafinesque, who pretended to distinguish three species, viz. *O. humifusa*, *O. cæspitosa*, and *O. mesacantha* (sometimes erroneously accredited to Nuttall), which cannot be made out, and which I have again united under their author's name. — The following is probably only a Southern variety of this species: —

O. grandiflora, E.: subadscendens; articulis majusculis; pulvillis remotis; setis tenuissimis; aculeis subnullis; floris grandis ovario elongato; petalis sub-10 latissimis; stigmatibus 5; bacca elongata clavata.

On the Brazos, Texas. — Joints often 5–6 inches long; pulvilli nearly an inch apart. Flowers 4½–5 inches in diameter, red in the centre; petals 2 inches long or more, and 1½ wide.

Dr. Bigelow collected on his tour from Arkansas to Santa Fé several forms, which, though somewhat distinct, are perhaps not entitled to be considered species. The true *O. Rafinesquii* does not seem to occur west of the western line of Missouri and Arkansas. The Western forms or subspecies are: —

O. cymochila, E. & B. in P. R. R.: diffusa; articulis orbiculatis; pulvillis subremotis stramineo- seu fulvo-setosis plerisque armatis; aculeis 1–3 robustioribus albidis basi fulvis patentibus deflexisve, additis

sæpe 2–3 minoribus; stigmatibus 8; bacca obovata; seminibus undulato-marginatis majusculis.

Var. β. MONTANA: subinermis; stramineo-setosa.

Along the Canadian River east of the Llano Estacado, and on that plain. Var. β. near Albuquerque. — Joints 2½–3 inches in diameter, in β. larger; longer spines 1–2 inches long. Fruit short, pulpy, sweet. Seed 2½ lines in diameter, with a very sharp irregularly wavy or twisted border. — The var. β. seems to unite the common *O. Rafinesquii* with this form.

O. STENOCHILA, E. & B. l. c.: prostrata; articulis obovatis; pulvillis remotis stramineo-setosis, superioribus solum armatis; aculeis singulis albidis patulis, 1–2 minoribus deflexis sæpe adjectis; bacca obovata clavata; seminibus crassis anguste marginatis.

Zuni, Western New Mexico. — Joints 4 inches long and 3 wide; spines 1–1¼ inches long. Fruit green or pale red, very juicy, 1½ or sometimes even 2½ inches long. Seeds quite peculiar, regular, much thicker in proportion than those of most other *Opuntiæ*, and with a very narrow edge. — Another form, with smaller and rounder joints, more spines, smaller fruit, but similar seeds, was found in the same neighborhood.

All the forms described above have fibrous roots. The following are principally characterized by their bulbous or tuberous roots, but can hardly be otherwise distinguished from the forms already described. Both are found westward of the range of *O. Rafinesquii* proper, and may be considered as subspecies, the peculiarities of which are readily propagated by seeds.

O. MACRORHIZA, E. in Pl. Lindh. part 1: prostrata, sæpe adscendens, radicibus tuberosis; articulis obovato-orbiculatis perviridibus; pulvillis subremotis rufo-setosis, superioribus solum armatis; aculeis singulis validis sæpe variegatis patulis, 1–2 gracilioribus deflexis subinde additis; alabastro acuminato; petalis circiter 8 sulphureis basi miniatis; stigmatibus 5; bacca obovata basi clavata, umbilico lato; seminibus subregularibus compressis minoribus.

Sterile, rocky places on the Upper Guadalupe River, in Texas: fl. May and June. — Roots in young specimens fusiform, in old ones enlarged to fleshy tubers, sometimes 2 or 3 inches in diameter. Joints 2½–3½ inches long, the leaves and bristles the same as in *O. Rafinesquii*. Flowers 3 inches in diameter. Fruit green or pale purple, smaller and sweeter than that of *O. Rafinesquii*.

O. FUSIFORMIS, E. & B. l. c.: subprostrata; radicibus elongato-fusiformibus; articulis orbiculatis; pulvillis setas elongatas virescenti-fuscas gerentibus, plerisque vel solum superioribus armatis; aculeis 2–3 gracilibus albidis deflexis seu patentibus; floribus minoribus; stigmatibus 8; bacca ovata; seminibus majusculis subregularibus.

Kansas and Nebraska, in the regions of the Cross-Timbers, from the Canadian to the Big Bend of the Missouri. — Roots elongated tubers ½–1 inch in diameter; joints about 3–4 inches long; spines an inch or a little more in length, slenderer and paler than in *O. Rafinesquii.* Flowers 2–2½ inches in diameter. Seed 2¾ lines wide. This plant has been distributed by me under the name of *Opuntia bulbosa.*

17. O. FUSCO-ATRA, E. in P. R. R.: diffusa; articulis orbiculato-obovatis tuberculatis; pulvillis subremotis magnis griseo-tomentosis, inferioribus solum inermibus; setis numerosis robustis longiusculis fuscis; aculeis subsingulis robustis fusco-atris suberectis, altero breviore deflexo sæpe adjecto; floris flavi ovario conico pulvillos 12–18 fulvo-villosos et fusco-setosos gerente; stigmatibus 5.

Sterile places in prairies, west of Houston, Texas: fl. May. — The stout brown, or above almost black spines, and the thick bunches of unusually stout brown bristles on the small joints, give this plant a very distinct appearance. Joints 2½–3 inches long; pulvilli 6–9 lines apart; bristles 2–3 lines long; spines 1–1¼ inches long, the lower one, when present, about half as long, but hardly less stout. Flower nearly 3 inches in diameter; ovary an inch long, rather slender, its pulvilli covered with long grayish-brown wool, and the upper ones with a few bright-brown bristles.

18. O. VULGARIS, Mill.: diffusa, prostrata; radice fibrosa; articulis obovatis seu suborbiculatis crassis læte seu pallide viridibus plerumque inermibus; foliis ovatis cuspidatis fere adpressis; pulvillis subremotis parvis subimmersis setas paucas abbreviatas virescenti-stramineas gerentibus; aculeis rarissimis singulis robustis variegatis suberectis; alabastro subgloboso obtuso; ovario clavato pulvillis sub-10 stipato; petalis sub-8; stigmatibus 5; bacca obovata clavata; seminibus regularibus crassis crasse marginatis.

From the southeastern coast of Massachusetts to Georgia and Florida; apparently only in the low countries east and southeast of the Alleghany Mountains, generally not far from the sea-coast: fl. May and June. — Joints 2–4 inches long and 2–2½ in diameter, rather thick and fleshy. Leaves 2–2½ lines long, generally appressed, only in

very vigorous specimens more patulous: spines, when present, less than 1 inch long, but stout. Flower about 2 inches in diameter, pale yellow. Seed 2½ lines in diameter. It seems to be well distinguished from *O. Rafinesquii* (which grows only west of the Alleghanies) by the smaller size, paler color, small pulvilli, usually the absence of spines, the smaller flower, with all the parts less numerous, and especially by the short, thick, and more or less appressed leaves.

§ 5. *Pubescentes:* erectæ seu procumbentes: articuli pubescentes: folia minuta: aculei subnulli.

* *Flavifloræ.*

19. O. MICRODASYS, Lehm.: erecto-patula; articulis oblongis obovatis seu orbiculatis pubescentibus læte viridibus; foliis minutis; pulvillis confertis inermibus lanam flavidam setasque numerosas gracillimas flavas gerentibus.

Only south of the lower Rio Grande, near Rinconada, etc. — Plant 2–4 feet high; joints 2–3 inches long, 1½–2 wide; pulvilli ¼–⅓ of an inch apart.

20. O. RUFIDA, E. in B. C. R.: erecto-patula; articulis late-obovatis seu suborbiculatis pubescentibus; foliis longe acuminatis; pulvillis confertis setas rufidas graciles numerosissimas gerentibus inermibus; floris flavi ovario obovato pulvillis numerosis instructo; stigmatibus 7 in capitulum congestis.

Common about Presidio del Norte, on the Rio Grande: fl. May. — Stem 2–4 feet high, much branched; joints 3–6 inches long; leaves 2½ lines long. Flower 2½ inches in diameter, with 40–50 pulvilli on the ovarium. — Apparently near *O. microdasys* and *O. puberula;* distinguished from the former by the rounded joints, larger leaves, and red-brown bristles; from the latter by the entire absence of spines, and of the purplish spot which in that species surrounds the pulvillus. Further investigations are necessary to decide about these closely allied forms, as about most species of this intricate genus.

* * *Rubrifloræ.*

21. O. BASILARIS, E. &. B. l. c.: humilis; articulis obovatis seu triangularibus glaucescentibus pubescentibus e basi proliferis; foliis minutis; pulvillis subconfertis fulvo-villosis setas gracillimas demum numerosissimas fulvidas et subinde aculeolos setiformes caducos gerentibus; floris purpurei ovario obovato pulvillis plurimis instructo;

stigmatibus 8 in capitulum congestis; bacca obovata late umbilicata (sicca?); seminibus magnis crassis subregularibus.

On Williams's River, the Colorado, and the Mojave, and down to the Gila: fl. April and May. — Habit very different from any other of our *Opuntiæ;* the stout obovate or fan-shaped joints (5–8 inches long) originate from a common base, forming a sort of rosette. Leaves only one line long, 4–6 lines apart; pulvilli red-brown, somewhat immersed. Flower about 2½ inches in diameter; ovary with 40–60 pulvilli. Fruit apparently dry, thereby approaching the next section. Seed 3 lines in diameter, 2 lines thick.

Mr. Schott has observed, on the dividing ridge of the California mountains, west of the mouth of the Gila, and again in the Santa Cruz Valley, Sonora, a very similar but suberect species, 3 feet high, spineless, inclined to assume a purplish hue, which he seems to have confounded with *O. basilaris.* Can it be *O. rufida*, or is it an undescribed species?

§ 6. *Xerocarpeæ:* diffusæ: articuli suborbiculati vel tumidi: aculei plurimi: bacca sicca aculeolata: semina eburnea, magna, plerumque latissime marginata.

* *Articuli compressi suborbiculati.*

22. O. HYSTRICINA, E. & B. l. c.: diffusa; articulis obovato-orbiculatis; pulvillis subconfertis setas pallidas rutilasve gerentibus, omnibus armatis; aculeis 5–8 superioribus validis elongatis angulatis seu tortis patulis vel deflexis, inferioribus 5–7 gracilioribus radiantibus; bacca ovata aculeolata, umbilico planiusculo; seminibus maximis.

West of the Rio Grande, to the San Francisco mountains. — Joints 3–4 inches long; pulvilli 5–6 lines apart, unusually large; longer spines 1½–3 and even 4 inches long, brownish; lower radiating ones white, 4–9 lines long. Fruit an inch long; upper pulvilli with 4–6 bristly spines. Seeds 3½ lines in diameter, among the largest in this genus.

23. O. MISSOURIENSIS, DC. (Cactus ferox, *Nutt. Gen.*): prostrata; articulis obovatis vel suborbiculatis tuberculatis; foliis minutis; pulvillis subconfertis stramineo-setosis, omnibus armatis; aculeis 5–10 exterioribus radiantibus setiformibus albidis, 1–5 interioribus robustis albidis seu rufescentibus; floris flavi intus aurantiaci ovario obovato vel subglòboso spinuloso; stigmatibus 5–10 viridibus; bacca spinosa, umbilico plano; seminibus magnis irregularibus.

Var. α. RUFISPINA, E. & B.: articulis orbiculatis; aculeis interioribus 3 – 5 validis fuscis; bacca ovata.

Var. β. PLATYCARPA, E.: articulis obovato-orbiculatis; aculeis interioribus subsingulis validis fuscis; bacca depresso-globosa late umbilicata.

Var. γ. MICROSPERMA, E.: articulis aculeisque præcedentis; bacca ovata breviter aculeolata; seminibus minoribus anguste marginatis.

Var. δ. SUBINERMIS, E.: articulis elongato-obovatis, pulvillis subremotis inferioribus inermibus, superioribus aculeos paucos breves gerentibus.

Var. ε. ALBISPINA, E. & B.: articulis late obovatis; aculeis 6 – 12 omnibus albis gracilioribus; bacca ovata.

Var. ζ. TRICHOPHORA, E. & B.: articulis ovatis; pulvillis confertis; aculeis 10 – 18 setiformibus (in articulis vetustis numerosioribus) capillaceis flexuosis; bacca ovata; seminibus maximis.

From the Upper Missouri to the Canadian; principally occupying the western plains, but also on the mountains towards Santa Fé and west of it. — The last-mentioned variety (which I would consider a distinct species, were it not for the var. *albispina*, which seems to unite it with the others) has been found only on the mountains near Albuquerque: all the other forms occur on the Upper Missouri, and α. and ε. also on the Canadian. Other and intermediate forms of this variable but nevertheless well-characterized species will no doubt be found in the wide territory inhabited by it. It flowers in May and June. — Joints 2 – 4, rarely 4 – 6 inches long, and 2 – 3½ inches wide, light green; leaves 1½ – 2 lines long; larger spines 1 – 1½, rarely 2 inches long, in δ. not more than 3 – 6 lines long. Flowers 2 – 3 inches in diameter, with short green stigmata forming a compact head. Fruit 1 – 1¼ inches long, with shorter or longer spines, and a rather shallow umbilicus. Var. β. has a remarkably large flat fruit. Seed generally about 3 lines, but in γ. only 2 lines, in diameter.

24. O. SPHÆROCARPA, E. & B. l. c.: diffusa; articulis orbiculatis tuberculatis; pulvillis confertis stramineo-setosis plerisque inermibus, summis solum aculeos 1 – 2 deflexos patulosve majores gerentibus, adjectis sæpe 1 – 3 brevioribus; bacca globosa vix aculeolata; seminibus mediis.

Mountains near Albuquerque, New Mexico. — Joints 3 inches in diameter, strongly tuberculated; pulvilli 4 or 5 lines apart; spines 6 – 12 lines long, reddish-brown, often single or 2 or 3 together, with or without smaller ones, which never occurs in any form of O. *Missouriensis*, where a large number of small setaceous spines is found, whether larger ones are present or not. Fruit 9 lines in diameter, with a small flat umbilicus. Seeds 2½ lines in diameter.

* * *Articuli tumidi ovati.*

25. O. ERINACEA, E. & B. l. c.: adscendens; articulis ovatis seu teretiusculis; pulvillis confertissimis omnibus armatis; aculeis 5 – 10 gracilibus rubellis, 3 – 5 elongatis; bacca ovata aculeolata; seminibus magnis subregularibus.

Near the Mojave, between the Colorado and the Californian mountains. — Joints 2 – 2½ inches long, 1 – 1½ broad, and ½ – ¾ thick, sometimes almost cylindrical, densely covered with large white pulvilli, which are only 2 – 3 lines apart. Spines 6 – 14 or even 20 lines long, slender but stiff. Fruit an inch or more in length. Seeds nearly 3 lines in diameter.

26. O. ARENARIA, E. in B. C. R.: adscendens; articulis obovatis compressis seu teretiusculis tuberculatis; foliis minutis; pulvillis subconfertis pallide setosis; aculeis 1 – 4 robustioribus albidis fuscatisve, cum inferioribus brevioribus 2 – 6 albis; floris sulphurei ovario obovato; petalis emarginatis; stigmatibus 5; bacca oblonga spinulosa; umbilico infundibuliformi; seminibus magnis irregularibus.

Sandy bottoms of the Rio Grande near El Paso: fl. May. — Spreading 2 – 3 feet, ½ – 1 foot high; roots stout, creeping horizontally; joints 1½ – 3 inches long, 1 – 2 inches wide, and ½ – ¾ thick, more strongly tuberculated than the allied species; leaves only a line long; pulvilli 3 – 5 lines apart, very bristly, especially on the old joints; upper spines 9 – 15 lines long. Flower 2 – 2½ inches in diameter. Fruit about an inch long. Seeds 2½ – 3 lines in diameter. This is the only one of our Cactaceæ on which the Cochenille has been found.

27. O. FRAGILIS, Haw. (Cactus fragilis, *Nutt.*): subdecumbens; articulis parvis ovatis subcompressis tumidis vel subglobosis vix tuberculatis nitide viridibus; foliis minutis; pulvillis subconfertis magnis albo-tomentosis, vix setulosis; aculeorum 1 – 4 robustiorum summo valido angulato fuscato porrecto, ceteris debilioribus pallidioribus patulis seu radiantibus; aculeis inferioribus 2 – 6 gracilibus albis radiantibus; floribus minoribus; bacca ovata vix spinulosa, umbilico infundibuliformi; seminibus paucis magnis subregularibus.

Fertile prairies, or sterile places, on the Upper Missouri and Yellowstone, to the mountains and south to Santa Fé. — Size and shape of the joints variable; fruit-bearing joints compressed, 1½ – 2 inches long, 1 – 1¼ wide, and ½ – ¾ thick; others smaller and more tumid. Leaves a line long, hardly longer than the large pulvilli, red. Pulvilli 4 – 6 lines apart, bristles very few, short, whitish, on the old joints a little more numerous, coarser, dirty yellow. Lower radiating spines 2 – 4 lines long; central spines 6 – 10 lines long, the other interior spines 3 – 8 lines long, often similar to the smaller lower spines. Fruit rather fleshy through the winter, getting dry in spring, nearly an inch long, with 20 – 25 pulvilli, of which only the upper ones bear a few short spines. Seeds few, usually only 5 or 6 in each fruit, 3 lines in diameter, with a wide and thick obtuse corky margin. — Often sterile, but abundantly propagated by the fragile joints.

28. O. BRACHYARTHRA, E. & B. l. c.: adscendens; articulis ovatis orbiculatisve tumidis sæpe subglobosis tuberculatis; pulvillis confertis parce setulosis; aculeis 3 – 5 validioribus 1 – 2 fuscatis patulis vel suberectis, cæteris deflexis; floris parvi ovario subgloboso pulvillos 12 – 15 vix aculeolatos gerente; stigmatibus 5.

Inscription Rock near Zuni. — The short and tumid joints (10 – 15 lines long) resemble the joints of a finger; the pulvilli 2 – 4 lines apart, even in the oldest parts of the plant with very few bristles; longer spines 9 – 12 lines long, terete. Ovary less than half an inch long. Flower apparently an inch in diameter. — Perhaps too near *O. fragilis;* but in the absence of good flowers and fruit, it is impossible to say whether it does not belong to even a different section, perhaps to the *Glomeratæ*, Salm.

Subgen. 3. CYLINDROPUNTIA, E. in B. C. R. Articuli cylindracei: flores magni vel parvi: bacca plerumque sicca: semina immarginata seu vix marginata: embryo circa albumen copiosius subcircularis; cotyledones contrariæ seu obliquæ, subinde parallelæ.

§ 1. *Clavatæ:* prostratæ: articuli breves, clavati, adscendentes, textura lignosa laxe reticulata: flores flavi majusculi: bacca sicca, pulvillis numerosis setosissimis stipata, floris rudimentis persistentibus coronata.

29. O. CLAVATA, E. in Wisl. Rep.: articulis breviter clavatis læte viridibus; tuberculis ovatis; foliis subulatis minutis; aculeis albidis

scabrellis, interioribus 4 – 7 complanatis, inferioribus deflexis latioribus supra striatis subtus carinatis, superiore triangulato erecto; aculeis exterioribus 8 – 10 gracilioribus undique radiantibus; baccæ pulvillis setosissimis; seminibus rostratis.

Santa Fé and Albuquerque, on the plateaux: fl. in June and July. — Dense spreading masses, with joints 1½ – 2 inches long; tubercles 6 – 8 lines long; larger spines 6 – 15 lines long, and the broadest one ¾ – 1½ lines wide. Flower 2 inches in diameter. Fruit yellow, 1½ – 1¾ inches long, an inch in diameter, covered with 30 – 50 large pulvilli. Seed 2½ – 3 lines in the longest diameter. Cotyledons mostly oblique, or, as in most other *Opuntiæ*, incumbent. (The expression is not etymologically correct, but I use it to designate the direction of the face of the cotyledons towards the radicle.)

30. O. PARRYI, E. in Sillim. Journ. 1852: prostrata; articulis ovatis basi clavatis; tuberculis oblongo-elongatis; setis paucis; aculeis angulatis scabris rubellis demum cinereis, interioribus sub-4 validioribus compressis, exterioribus 4 – 8 divergentibus, extimis 6 – 10 gracilibus radiantibus; bacca ovata pulvillis sub-40 setosissimis stipata; seminibus erostratis.

On the Mojave, west of the great Colorado. — Joints 2½ – 3 or 4 inches long, attenuated below and somewhat so above; tubercles 9 lines long; inner spines 12 – 16 lines long, and the larger ones somewhat flattened, but less than a line wide; exterior spines 3 – 8 lines long, in two series. Fruit 1½ inches long. Seeds about 2 lines in diameter. — The original specimens of Dr. Parry were found farther south, near San Felipe. He describes the joints as 4 – 8 inches long, with shorter whitish spines or tubercles 6 – 12 lines long, and the flower as greenish-yellow. The Mojave plant is nearly allied to the last species, but may be distinguished by the shape of the joints, the narrower, darker-colored, more numerous spines, and the smaller and more regular seeds.

31. O. EMORYI, E. in B. C. R.: articulis cylindricis basi clavatis glaucis; tuberculis oblongo-linearibus elongatis; setis paucis; aculeis plurimis rufis, interioribus 5 – 9 validioribus triangulatis, compressis, exterioribus 10 – 20 pluriseriatis undique radiantibus; floribus flavis extus rubellis; bacca pulvillos 35 – 50 setosissimos inferiores aculeolatos gerentibus; seminibus valde inæqualibus irregularibus.

Arid soil, from El Paso through Sonora to the desert of the Colorado: fl. August and September. — The stoutest species of this section. Joints 4 – 6 inches long, curved, 1 – 1½ inches in diameter; tubercles 1 – 1½ inches long; longest spines 1½ – 2½ inches long, ¾ – 1 line wide; the exterior spines gradually smaller, and less angular. Fruit 2 – 2½ inches long, partly armed with spines 4 – 8 lines long. Seeds from 2¼ to 3¼ lines in diameter. Cotyledons oblique or accumbent.

32. O. Schottii, E. l. c.: articulis clavatis; tuberculis elongatis; pulvillis pauci-setosis; aculeis rubellis scaberrimis, interioribus sub-4 cruciatis, superiore triangulato, cæteris supra planis subtus convexis, latioribus; exterioribus 8 – 10 radiantibus gracilibus; bacca ovata pulvillos 35 – 40 pauci-setosos gerente; seminibus rostratis.

On the arid hills near the mouth of the San Pedro and Pecos, Western Texas. — Distinguished by the broad and very rough spines, which are dirty red, the larger ones with a white margin, and by the smaller number of bristles both on the pulvilli of the joints and of the fruit, where they are mostly turned upwards. Joints 2 inches long; tubercles 8 – 9 lines long; spines 1½ – 2 inches long; the radiating ones only 4 – 9 lines long. Seeds 2 lines in diameter. Cotyledons oblique.

Dr. Gregg has collected a similar plant near San Luis Potosi; which at present I know not how to distinguish from *O. Schottii.* The spines are stout, perhaps less rough, and narrower, 12 – 15 in number; some of them borne on the upper margin of the pulvillus, which I have never seen in *O. Schottii.* Tubercles an inch long.

33. O. Grahami, E. l. c.: radicibus fusiformibus; articulis clavatis; tuberculis oblongis; foliis ovatis cuspidatis; setis demum plurimis; aculeis gracilibus rubellis, interioribus 4 – 7 teretiusculis angulatisve, exterioribus 4 – 6 brevibus; bacca pulvillos sub-30 setosissimos gerente; seminibus erostratis.

Sandy bottoms of the Rio Grande near El Paso: fl. June. — Joints 1½ – 2 inches long; tubercles 6 – 7 lines long; leaves thicker and in proportion shorter than in most other species, nearly 2 lines long. Fruit similar to that of *O. clavata.* Seed 2½ lines in diameter or more. Cotyledons regularly incumbent.

34. O. bulbispina, E. l. c.: radicibus fusiformibus; articulis parvis ovatis sæpe ex apice proliferis fragilibus; tuberculis ovatis brevibus; pulvillis parce setosis; aculeis teretiusculis scabrellis basi bulbosis, interioribus 4 cruciatis, inferiore longiore, exterioribus 8 – 12 radiantibus.

Saltillo, Mexico. — Spreading masses with joints an inch long or less; tubercles 4 – 6 lines long; interior spines 4 – 6, exterior ones 1½ – 3 lines long. Apparently near the South American *O. pusilla*, Salm., and perhaps belonging to the *Opuntiæ glomeratæ*, rather than here. Fruit unknown.

§ 2. *Cylindricæ:* adscendentes vel erectæ: articuli longiores, ovato-cylindrici seu elongati: textura lignosa compacta, tubum reticulatum vel truncum compactum formans: flores magni seu parvi, purpurei vel raro flavi: bacca sicca vel subcarnosa, floris rudimenta plerumque dejiciens, aculeata seu inermis.

* *Polyacanthæ:* lignum plerumque reticulato-tubulosum; articuli crassiores distincte tuberculati: aculei plures seu plurimi: flores plerumque rubri: semina immarginata.

† *Humiliores:* diffuse ramosæ: articuli subclavati: flores plerumque flavidi: baccæ siccæ, aculeatæ.

35. O. Davisii, E. & B. in P. R. Rep.: caule dense lignoso ramosissimo divaricato; articulis junioribus erectis elongatis basi attenuatis; tuberculis oblongo-linearibus; aculeis interioribus 4 – 7 subtriangularibus rufis vagina straminea laxa indusiatis divergentibus; aculeis inferioribus 5 – 6 gracilibus; bacca ovata pulvillis sub-25 aculeigeris stipata.

On the Llano Estacado, near the Upper Canadian River; common. — Spreading and somewhat procumbent, about 18 inches high; the only one in this section with dense wood. Joints 4 – 6 inches long, rather slender; tubercles 7 – 8 lines long; interior spines 1 – 1½ inches in length; lower ones 3 – 6 lines long. Fruits (all sterile, and perhaps not properly developed) an inch or more in length.

36. O. echinocarpa, E. & B. l. c.: erectiuscula; ramis numerosis patentissimis; articulis ovatis basi clavatis; tuberculis ovatis confertis; aculeis majoribus sub-4 albidis stramineo-vaginatis, 8 – 16 minoribus undique radiantibus; flore flavo (?); bacca globosa depressa seu hemisphærica late profundeque umbilicata pulvillis sub-40 aculeatissimis stipata; seminibus late commissuratis.

Var. *β.* major: elatior; articulis elongatis; aculeis longioribus laxius vaginatis paucioribus; baccis globosis pulvillos pauciores (25) gerentibus.

In the valley of the Lower Colorado; *β.* in Sonora. — Var. *a.* is a low shrub, 6 – 18 inches high; joints 1 – 2½ inches long; tubercles 4 – 5 lines long; spines not over an inch in length. Flower apparently yellow, about 1½ inches in diameter and somewhat persistent on the fruit. Fruit very shallow, saucer-shaped, with few large seeds. Var. β. is 4 or 5 feet high; joints 8 – 10 inches long; interior spines 1 – 1¾ inches long. Fruit globose or even ovate, with 25 pulvilli. Seeds the same in both.

37. O. SERPENTINA, E. in Sill. Journ. 1852: erectiuscula seu subprostrata; articulis elongatis cylindricis; tuberculis ovatis; aculeis 7 – 9 albido- seu rufido-vaginatis; flore flavo extus rubello; bacca subhemisphærica late et profunde umbilicata villosa aculeatissima.

Near the sea-coast about San Diego, California. — Sometimes 4 – 5 feet high, but often prostrate; joints 6 – 12 inches long; spines less than one inch long. Flower cup-shaped, 1¼ inch wide. Fruit apparently like that of the last species, but "long woolly" and with fewer pulvilli, also often crowned with the persistent flower. Seed unknown; said to be large. — Closely allied to the foregoing species. Can this be Nuttall's *Cactus Californicus* (Cereus, *Torr. & Gr. Fl.*), with cylindric branches, yellow flower, and spiny fruit?

†† *Deciduæ:* arborescentes: articuli tumidi, perfragiles: tubercula depressa: flores purpurei: baccæ sæpissime steriles, proliferæ.

38. O. PROLIFERA, E. l. c.: ramis divaricatis; articulis ovatis seu ovato-cylindricis perviridibus versus ramorum apicem congestis; tuberculis obovato-oblongis prominulis; aculeis 8 – 10 obscuris stramineo- seu rufo-vaginatis, singulo centrali, cæteris patulis; flore rubro; bacca ovata aculeolata plerumque sterili prolifera.

On arid hills about San Diego, California, forming extensive thickets. — Stems 2 – 4, and sometimes even 6 – 7, inches in diameter, 3 – 10 feet high; joints 3 – 6 inches long and 1½ – 2 in diameter; tubercles about 6 lines long; spines 6 – 14 lines long, the lower ones shorter. Flowers red, salver-form, 1½ inches in diameter.

39. O. FULGIDA, E. in B. C. R.: ramis divaricatis; articulis ovatis seu ovato-cylindricis glaucescentibus versus ramorum apicem congestis; tuberculis ovato-oblongis prominulis; aculeis 5 – 9 subæqualibus laxe vaginatis undique stellato-porrectis; flore purpureo parvo; bacca ovata inermi vix tuberculata; seminibus parvis rostratis.

Mountains of Western Sonora: fl. July and August. — Plant 5 – 12 feet high; joints 3 – 8 inches long; tubercles rather elongated, 6 – 7 lines long; spines 1 – 1¼ inches long, hiding the whole plant with their lustrous sheaths. Flower about one inch or less in diameter. Fruit fleshy, 1 – 1¼ inches long, usually sterile. Seeds smaller than in any other Opuntia examined, 1 – 1½ lines long.

40. O. Bigelovii, E. in P. R. R.: ramis erectis adscendentibusve; articulis ovato-cylindricis pallide virescentibus congestis; tuberculis subhemisphæricis depressis confertis; aculeis 6 – 10 robustioribus et totidem gracilioribus inferioribus; ovario tuberculato; bacca tuberculata subinde (sterili?) aculeolata; seminibus parvis.

On Williams's River, of the Californian Colorado. — Stem 3 – 4 inches thick and 10 – 12 feet high; the branches forming a dense contracted head, with joints 2 – 6 inches long; tubercles 3 – 4 lines long; larger spines about an inch long, smaller ones 4 – 7 lines long.

The three foregoing species represent this subsection west of the California mountains, and east of them both south of the Gila and north of it, and seem to be well distinguished from one another by the characters indicated.

††† *Cristatæ:* frutescentes vel arborescentes: articuli cylindrici: tubercula plerumque cristata prominula: flores purpurei: baccæ inermes seu rarius aculeatæ.

41. O. Whipplei, E. & B. in P. R. R.: caule erecto seu rarius subprocumbente divaricato-ramoso; articulis cylindricis; tuberculis ovatis confertis; aculeis brevibus cinereo- seu stramineo-vaginatis, 1 – 4 majoribus, 2 – 8 brevioribus deflexis vel radiantibus; flore rubro; bacca subglobosa tuberculata flava inermi; seminibus regularibus.

Var. *α.* LÆVIOR: humilior, aculeis paucis deflexis.

Var. *β.* SPINOSIOR: elatior, aculeis plurimis radiantibus.

From Zuni westward to Williams's River (*α.*), and south of the Gila (*β.*): fl. in June. — The first state is from a few inches to 3 – 6 feet high; the second forms small trees 8 – 10 feet high. Joints ½ – ¾ inch in diameter; tubercles about 5 lines long; spines very variable, between 3 and 9 lines long. Flower (of var. *β.*) 1¼ – 1½ inches in diameter. Fruit about an inch long.

42. O. arborescens, E. in Wisl. Rep. (*O. stellata*, Salm.): arborescens; ramis verticillatis horizontalibus vel pendulis; articulis verticillatis cylindricis; tuberculis cristatis prominentibus; aculeis 8 – 30 stellato-divaricatis; flore purpureo magno; bacca subhemisphærica tuberculato-cristata flava inermi; seminibus regularibus.

From north and east of Santa Fé and the Llano Estacado, to Zuni; extending southward deep into Mexico: fl. May – July. — Northward 5 – 6, south 10 – 20 or more, feet high; easily characterized by the horizontal and verticillate branches, etc.

43. O. ACANTHOCARPA, E. & B. in P. R. R.: arborescens; ramis alternis adscendentibus; articulis cylindricis; tuberculis elongatis; aculeis 8 – 25 stellato-divaricatis; bacca subglobosa tuberculata aculeata; seminibus multangulatis.

Mountains of Cactus Pass, between Santa Fé and the Western Colorado. — Stems 5 – 6 feet high; branches few, alternate, and separating from the stem at an acute angle. Joints (as in the preceding) 4 – 6 or 8 inches long, about 1 inch in diameter; tubercles 9 – 10 lines long; interior spines 1 – 1¼ inches, exterior ones 4 – 10 lines, long. Spines of fruit on the depressed tubercles 3 – 6 lines long. Seeds large, unlike those of any other Opuntia seen by me.

44. O. MAMILLATA, A. Schott in litt., B. C. R.: arborescens, divaricato-ramosissima; articulis crassis abbreviatis perviridibus; tuberculis tumidis; aculeis 4 – 6 brevibus plerisque deflexis; flore parvo purpureo; bacca obovata inermi; seminibus parvis.

Sonora, on the Sierra Babuquibari, in fertile soil: fl. July and August. — Stems 5 – 6 feet high; joints 3 – 4 inches long, 1½ inches in diameter; the swelling tubercles very prominent; spines 3 – 9 lines long, sometimes almost wanting. Flowers an inch or less in diameter.

45. O. THURBERI, E. in B. C. R.: frutescens, erecta; articulis cylindricis gracilibus elongato-tuberculatis; aculeis 3 – 5 brevibus divergento-deflexis; flore miniato.

Bacuachi, Sonora: fl. June. — Much more slender than any species yet enumerated in this subgenus. Joints ½ inch in diameter; tubercles 9 lines long; spines 3 – 8 lines long, the lowest one the stoutest. Flower 1½ inches in diameter.

* * *Monacanthæ:* lignum densum: articuli graciliores obscure tuberculati: aculei singuli: flores flavi seu rubri; semina plus minus marginata.

46. O. WRIGHTII, E. l. c.: frutescens, erecta; articulis cylindricis gracilibus elongato-subtuberculatis; aculeis subsingulis porrectis vel subdeflexis; flore miniato.

On steep mountain-sides, from the Limpio to the Pecos, and in Northern Mexico: fl. June and July. — Shrub 2 – 4 feet high, 1 – 1½

inches thick. Joints 4 lines in diameter; tubercles depressed, 7 – 9 lines long; spines 8 – 10 lines long. Flower about 1 – 1¼ inches in diameter.

47. O. ARBUSCULA, E. l. c.: arborescens, erecta, capitato-ramosissima; articulis læte viridibus elongato-subtuberculatis; aculeis subsingulis porrectis vel subdeflexis; flore flavo-virescente.

On the Lower Gila, near Maricopa village: fl. June. — A truly arborescent form, with a solid trunk of 4 or 5 inches in diameter, 7 – 8 feet high; joints 2 – 3 inches long, about 4 lines in diameter; tubercles indistinct, about 6 lines long; spine 9 – 12 lines long, often with 1 or 2 smaller ones under it. Flower 1½ inches in diameter.

48. O. VAGINATA, E. in Wisl. Rep. (partim): frutescens, erecta; ramis erectiusculis; articulis subtuberculatis; aculeis subsingulis; bacca obovata tuberculata coccinea.

Albuquerque, New Mexico, and southward. — Shrub 3 – 5 feet high, 1 – 1½ inches thick; joints 3 – 4 lines in diameter; tubercles rather distinct, 6 – 9 lines long. Fruit 8 – 9 lines long. Seed about 2 lines in diameter. Perhaps a stout form of the next species.

49. O. FRUTESCENS, E. in Pl. Lindh. 1845: frutescens, erecta; ramis erectiusculis; articulis teretibus; aculeis subsingulis; flore parvo virescente; bacca obovata haud tuberculata coccinea.

Var. *α.* LONGISPINA: articulis nascentibus stipitatis; aculeis validioribus longioribus laxe vaginatis.

Var. *β.* BREVISPINA: articulis nascentibus sessilibus; aculeis gracilioribus brevioribus arcte vaginatis.

From the Colorado of Texas to Matamoras and Saltillo, westward to Sonora and the Californian Colorado: fl. June to August. — Var. *α.* is the usual Western form; *β.* occurs only in Texas and Eastern Mexico. — Shrub 3 – 5 feet high, stem 1 – 1½ inches thick; joints 2 – 3 lines in diameter; indistinct tubercles 3 – 5 lines long; spines in *α.* 1 – 2 inches, in *β.* 4 – 6 lines, long. Flower 7 – 9 lines in diameter. Fruit 5 – 9 lines long. Seeds few, usually 1½ lines in diameter.

50. O. TESSELLATA (O. ramosissima, *E. in Sill. Journ.* 1852): frutescens, erecta seu diffusa, divaricato-ramosissima; articulis gracilibus tessellato-tuberculatis cæsiis; tuberculis 5 – 6 angulatis planis inermibus seu aculeum elongatum paucosque minutos gerentibus; flore purpurascente parva; bacca setosissima sicca.

Valley of the Lower Colorado from Sonora to the California moun-

tains: fl. May to September. — Stems 2 – 6 feet high, at the base 1 – 3 inches thick; joints 3 – 3½ lines in diameter, ashy gray; the singular flattened and angular tubercles 2½ – 3 lines long; spines 1½ – 2 inches long, crowded together at the upper end of each year's growth, very loosely sheathed. Flower purple, half an inch in diameter. Fruit 9 – 10 lines long, covered with reddish-brown bristles. Seed 2 lines or less in diameter.

⁂ The material for the present study of our *Cactaceæ* is not as full as would have been desirable in the examination of so difficult a family. Hence it may sometimes have happened, that what I have endeavored to distinguish as species are forms which properly belong together; or I may have combined as one species incomplete specimens of quite distinct plants. The fear of confusing heterogeneous plants under one name, and the desire to indicate to future explorers all the different forms known to me, combined to induce me to proceed as I have done.

For those who naturally may be horrified at the idea of 117 species of *Cactaceæ* in a territory where, a few years ago, scarcely half a dozen were known, I will indicate how the mass of material may be comprehended under fewer types.

Of *Mamillariæ* the species 1 – 9 are quite distinct, and can in no manner be united; 10 – 12 might perhaps be considered as forms of a single species; 13 – 17 are all very distinct; 18 and 19, 20 – 23, 25 and 26, 27 and 28, may possibly be forms of only four types, instead of 10, as I have enumerated them, thus referring my 30 species to 22 types.

In the genus *Echinocactus* the following species might be united: 1 and 2, 7 and 8, 9 and 10, 12 and 13, 14 and 15, — leaving 15 instead of 20 types.

The following species of *Cereus* will perhaps bear reduction: Nos. 1 and 2, 3 and 4, 5 – 7, 10 and 11, 12 – 14, 16 and 17, 18 – 22 (though some of them, of which I do not even know the flowers, may prove to belong even to different sections!), 23 and 24, — thus reducing my 31 species to 18 types.

Opuntia is a still more difficult genus, and mistakes are here most easily made. Many of them are as yet very incompletely known; and without being able to compare a great number of living specimens in their native state and in all stages of development, it can hardly be expected that any one should know beforehand what constitutes the specific characters in these plants. I have tried to unite the forms which seemed to justify such a proceeding (see, e. g. *O. Rafinesquii*, here made to comprise quite a suite of forms as subspecies). Still it may be thought that a greater reduction was yet desirable; but with our present data this would involve great danger of jumbling heterogeneous materials together. Nos. 5 and 7 (of which latter neither flower nor fruit is known) can perhaps be united; also 9 and 10, 11 and 12, 13 and 14, 16 and 17, 19 and 20, 22-24, 25-28, 29 and 30, 31-33, 35-37, 38-40, and 48 and 49, — leaving 31 types, 29 of which are indigenous to our territory, and two cultivated.

Geography of the Cactus Region of the United States.

The localities where our *Cacti* grow are so little known to those who have not made the geography of the West a particular study, or are familiar with the publications of our Western explorers, that it seems necessary to add a few explanatory remarks.

Texas, as at present organized, is bounded southeasterly by the Gulf of Mexico, into which the following rivers mentioned in the foregoing pages empty, following the order from east to west: the Brazos, the Colorado with the Llano, the Guadalupe with the Pierdenales and San Antonio, the Nueces, and the Rio Grande. The latter forms the southern and southwestern boundary as high up as El Paso. On it are the towns of Matamoras (not far from its mouth), Mier, Laredo; and higher up, Presidio del Rio Grande; then Fort Duncan or Eagle Pass (southwest of which is Santa Rosa, in the State of Coahuila); next comes the mouth of the San Pedro or Devil's River (a small river or rather torrent running southward), and not far from it the mouth of the Pecos or Puerco, which rises at the north-northwest in the upper parts of New Mexico. Between the mouth of the Pecos and El Paso we notice only Presidio del Norte, San Elizario, and a "cañon" below the latter. The valley of the Limpio, a little more to the northward between the Pecos and El Paso, is a remarkable locality; probably because there porphyritic rocks take the place of the cretaceous formation of the more eastern districts.

Chihuahua is the well-known capital of the Mexican State of the same name, south of El Paso.

The Canadian River is a southern tributary of the Arkansas, running eastwardly very nearly under the 35th degree of latitude, and bounding on the north the elevated plains known as the *Llano Estacado*, in the northwestern parts of Texas and the adjoining regions of New Mexico.

The Upper Rio Grande runs through New Mexico from north to south; the capital, Santa Fé, is not far from the river, in lat. 35½°; and the town of Albuquerque is a little below. Doñana is a small place on the river, above El Paso. El Paso itself, where the Rio Grande breaks through the mountain ranges, changing its heretofore southern to a southeastern course, is the central point of our Cactus region, partly from its geographical position, and partly because many of our explorers have made it the centre of their operations.

The present southwestern boundary of the United States runs from El Paso irregularly westward through the former Mexican State of Sonora, to the Colorado "of the West," or "of California," which comes from the South Pass in the Rocky Mountains, and runs southwestward and southwardly. Its principal tributaries rise in the east; those most important to us are the Little Colorado or Colorado Chiquito, under the 35th and 36th degree of latitude; Bill Williams's Fork, or Williams's River, as it is lately styled, further south; and in lat. 33° the Gila River, which rises near the "Coppermines," northwest of El Paso.

Proceeding from Santa Fé westward, we find the Indian town of Zuni, on the head-waters of the Little Colorado; then the San Francisco mountains; the Cactus Pass, at the head of Williams's River, and this stream itself. All this territory is at present included in the political organization of New Mexico, though uninhabited by whites.

West of the Colorado, in lat. 35°, is the Mojave or Mohave River, rising in the Sierra Nevada near the Cajon Pass; lower down, opposite the mouth of the Gila, the country is a sandy desert extending westward nearly to San Felipe, on the eastern slope of the California mountains in the same latitude. On the western sea-coast the town of San Diego is the only interesting point for the plants under review.

Geographical Distribution of the Cactaceæ in the Territory of the United States.

As to the geographical distribution of the *Cactaceæ*, our territory may properly be divided into eight regions, viz.: —

1. The Atlantic Region; which has only a single *Opuntia*, and that peculiar to it. Along the Southern coast some West Indian species may yet be expected.

2. The Mississippi Region, including the Western States, produces another *Opuntia*, which, in different distinct forms, extends into the 3d, 4th, and 5th regions.

3. The Missouri Region; namely, the Northwestern or Upper Missouri Territory to the Rocky Mountains. It furnishes

Two *Mamillariæ* of the subgenus *Coryphantha*, both extending into the 4th and 5th region; and

Three *Opuntiæ*, one of which only is peculiar.

4. The Texan Region; namely, the eastern and inhabited parts of Texas, westward to the San Pedro, and northward including the territory south of the Arkansas River. This region produces

Five *Mamillariæ*, two of them peculiar to this district;

Three *Echinocacti*, none of which are found in any other of our regions;*

Six *Cerei* (five *Echinocerei* and one *Eucereus*), all of them peculiar to this district; and

Six *Opuntiæ*, of which only three are restricted to it; among them is only a single cylindric *Opuntia*.

This region contains therefore altogether twenty species, fourteen of which are peculiar to it.

5. The New-Mexican Region; namely, Western, uninhabited, mountainous Texas, and Eastern New Mexico to the eastern headwaters of the Colorado of California. This region is our richest Cactus district. It has furnished sixty-five species, fifty-five of which are peculiar to it, viz.: —

Nineteen *Mamillariæ* (eight *Eumamillariæ*, ten *Coryphanthæ*, and one *Anhalonium*), of which sixteen are peculiar;

Nine *Echinocacti*, all of them belonging to this district only;

Sixteen *Cerei* (fifteen *Echinocerei*, fourteen of which are peculiar, and one *Eucereus*, common also to other regions); and

Twenty-two *Opuntiæ;* of these twelve are flat-jointed, four clavate, and five cylindrical ones: seventeen of these species are peculiar.

6. The Gila Region, comprising the whole valley of the Colorado

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* Always excepting Mexico itself, south of the Rio Grande, into which many, if not most, of our species extend.

south of lat. 36°, and the country of the Gila, its large southern tributary. This has thus far furnished thirty-six Cactaceæ, viz.: —

Five *Mamillariæ*, three of them peculiar species;

Six *Echinocacti*, none of them found elsewhere;

Seven *Cerei*, representatives of each of our four subgenera, and five of them peculiar;

Eighteen *Opuntiæ*, of which six (all peculiar) belong to the *Platopuntiæ*, two to the clavate and ten to the cylindric *Cylindropuntiæ;* one of the former and nine of the latter peculiar.

7. The Californian Region, namely, California west of the Sierra Nevada, and comprising the southwestern part of the present State of California, produces six *Cactaceæ*, five of which are peculiar. They are, —

One *Mamillaria;*

One *Echinocactus;*

One *Cereus* of the section *Eucereus;* and

Three *Opuntiæ;* one of them a *Platopuntia*, probably only a form of a more eastern species, and two peculiar *Cylindropuntiæ*.

8. The Northwestern Region, comprising the northern parts of the State of California, the Territories of Utah, Oregon, and Washington. This region has so far furnished only a single *Opuntia* (from Eastern Oregon), common also to the Missouri Region. — Mr. Geyer, in his account of his expedition to Oregon in 1843, mentions two *Mamillariæ* and a "*Melocactus*" (?), which latter he has not seen himself, nor are there any known specimens in existence.

Corrections and Additions.

P. 267. *Mamillaria scolymoides* has been collected by Mr. Wright, on the Pecos, in Western Texas.

P. 273. 9th line from top, dele "1" after "fuscatis."

P. 278. 5th line from top, for "parallelæ" read "contrariæ."

P. 286. *Cereus Berlandieri* is very near *C. pentalophus*, DC., but Prince Salm, who has cultivated both side by side, considers them well distinguished.

P. 300. *Opuntia Missouriensis* has been sent from Clear Water, on the Kooskooskie, in Oregon, by the Rev. Mr. Spalding.

Four hundred and twenty-ninth meeting.

August 13, 1856. — STATED MEETING.

The PRESIDENT in the chair.

Professor Treadwell, from the committee on the subject of meteorological observations, reported that Mr. Hall's observations are in due process of preparation for the press.

Professor W. B. Rogers made the following communication: —

" *Proofs of the Protozoic Age of some of the Altered Rocks of Eastern Massachusetts, from Fossils recently discovered.*

" It is well known that the altered slates and gritty rocks which show themselves interruptedly throughout a good part of Eastern Massachusetts, have, with the exception of the coal-measures on the confines of this State and Rhode Island, failed hitherto to furnish geologists any fossil evidences of a paleozoic age, although from aspect and position they have been *conjecturally* classed with the system of rocks belonging to this period. Indeed, the metamorphic condition of these beds generally, traceable no doubt to the sienitic and other igneous masses by which they are traversed or enclosed, would naturally forbid the expectation of finding in them any distinguishable fossil forms.

" Lately, through the kindness of Peter Wainwright, Esq., residing in the neighborhood, I have been led to examine a quarry in the belt of siliceous and argillaceous slate which lies on the boundary of Quincy and Braintree, about ten miles south of Boston, and, to my great surprise and delight, I found it to be *a locality of trilobites.*

" It appears that for several years past the owner of the quarry, Mr. E. Hayward, and his family, have been aware of the existence of these so-called *images* in the rock, which from time to time they have quarried as a ballasting-material for wharves; but *until now the locality has remained entirely unknown to science.*

" The fossils are in the form of casts, some of them of great size, and lying at various levels in the strata. So far as I have yet explored the quarry, they belong chiefly, if not altogether, to one species, which, on the authority of Professor Agassiz, as well as my own comparison with Barrande's descriptions and figures, is a species of *Paradoxides.* Of its specific affinities I will not now speak, further than to remark that the specimens agree more closely with Barrande's P. spinosus than with any other form which I have seen figured or described.

"The rock in which these fossils occur is a compact, dense, rather fine-grained silico-argillaceous slate or slaty sandstone, containing little or no carbonate of lime. In the quarry it displays two systems of joints, in one of which are seen the usual parallel markings due to the movement of contiguous surfaces upon each other under pressure, and it is much broken up by irregular cleavage planes. The strike of the beds appears to be about N. 70° E., and their dip towards the north and west at an angle of about fifty degrees. The narrow belt of slates and grits, of which the fossiliferous strata form a part, extends for some distance towards the north and east, and has also, it is said, been traced for several miles in the opposite direction. But as yet the discovery of fossils has been confined to the one locality.

"In crossing the belt either towards the northwest or in the opposite direction, we find the slates and grits to become more indurated and otherwise modified, after which, passing into beds of a semi-crystalline character, they give place to ranges of sienite. Thus the fossiliferous belt in this part of its course *is actually included between great masses of igneous rocks;* and it is not a little surprising, that, under conditions so favorable for metamorphic action, the fossil impressions should have been so well preserved.

"In regard to the distribution of the genus Paradoxides, Barrande, in his great work the 'Système Silurien de la Bohème,' has the following important observations: —

"'In Bohemia the genus Paradoxides characterizes exclusively the primordial Fauna, and does not extend beyond our protozoic schists (C). The twelve species which we have determined divide themselves almost equally between the two slaty belts of Ginetz and Skrey, and two are common to them both. In these two belts we find P. spinosus in all the localities which have afforded fossils, while each of the other species is restricted to a few points, principally those of Ginetz and Skrey.

"'In Sweden the Paradoxides belong exclusively to the local formations designated by Angelin as Regions A and B, representing jointly our protozoic slate formation (C) above mentioned. The region A is the lowest fossiliferous belt of Sweden, as it rests directly on the azoic rocks.

"'In Great Britain we know, according to the papers of Mr. Salter, that Paradoxides has been found in the Trappean group (Lingula flags of the Survey), which is the *oldest fossiliferous rock* of Wales, resting on the azoic sandstones of Harlech and Barmouth. There is therefore a perfect agreement in these three regions as to the geological horizon of the genus now under consideration. This agreement acquires still further importance from the affinities displayed equally and everywhere by the other types which accompany the Paradoxides; for instance, in Sweden we have Olenus and Conocephalites; in England, Olenus as recognized in the Trappean group.'

"As thus the genus Paradoxides is peculiar to the lowest of the paleozoic rocks in Bohemia, Sweden, and Great Britain, marking the primordial division of Barrande and the Lingula flags of the British Survey, we shall probably be called upon to place the fossil belt of Quincy and Braintree on or near the horizon of our lowest fossiliferous group; that is to say, somewhere about the level of the primal rocks, the Potsdam sandstone, and the protozoic sandstone of Owen containing Dikelocephalus in Wisconsin and Minnesota. *Thus for the first time are we furnished with data for fixing conclusively the paleozoic age of any portion of this tract of ancient and highly altered sediments, and, what is more, for defining in regard to this region the very base of the paleozoic column, and that too by the same fossil inscriptions which mark it in various parts of the Old World.*

"Referring to the occurrence of Paradoxides in the protozoic rocks of Europe, Barrande observes: 'The presence of this genus has not been satisfactorily proved in any other Silurian region, although this generic name has been applied to North American forms, such as Paradoxides Boltoni, P. Harlani, &c. The first of these is known to be a Lichas, and we know nothing of the others. The care with which J. Hall has described the trilobites of the Lower Silurian rocks of the country in question, is sufficient proof that he had not discovered any trace of Paradoxides at the time of publishing the first volume of the Paleontology of New York.' I may add to this, that in no subsequent publication have I seen any reference to the finding of fossils of this genus in the rocks of North America.

"One of the most curious facts relating to the trilobite of the Quincy and Braintree belt is its seeming identity with the P. Harlani described by Green in his Monograph of North American Trilobites.

This description, which is quite imperfect, was made out from a specimen of *unknown locality*, procured, some twenty-five years ago, by Dr. Harlan, from the collection of our well-known mineralogist, Mr. Francis Alger. That it is the same with the more conspicuous of our Quincy fossils is, I think, established by the comparison of a nearly complete specimen of the latter with the cast of P. Harlani taken from Mr. Alger's specimen, the original never having been returned. Considering the perfect agreement in lithological characters of the matrix as described by Green with that of the Quincy fossils, and the immediate recognition of this identity of mineral features by Mr. Alger on seeing my Quincy specimens, we can hardly doubt that the original specimen of P. Harlani came, either directly or through the drift scattered in the vicinity, from the same fossiliferous belt. Thus it appears that this vagrant fossil, so long without a local habitation, although not without a name, has at length been restored to its native seat, where it takes a prominent place in the dynasty of ancient living forms that marked the earliest paleozoic history of New England.

" In this connection I find a remark in Barrande which, besides being historically curious, has an interesting bearing on the specific affinities of our fossil : ' We see in different collections, and especially in that of the School of Mines and the British Museum, under the name of P. Harlani, from the United States, a cast of a trilobite which appears to us to be identical with P. spinosus, of great size, such as found at Skrey in Bohemia.' The cast here referred to, like that used in my comparison with the Quincy fossil, was doubtless one of the series of plaster copies prepared by Dr. Green to accompany his monograph. Its agreement with the P. spinosus harmonizes well with my own observation, already stated, of the close resemblance between the Quincy fossil and this Bohemian species.

" The occurrence of well-preserved fossils among rocks so highly altered, and so contiguous to great igneous masses, as are the fossiliferous slates of Quincy, may well encourage us to make careful search in other parts of New England where heretofore such an exploration would have been deemed useless. Although we cannot hope to build up the geological column of New England from the protozoic base just established to the carboniferous rocks, supposing all the intervening formations to be represented in this region, we may at least succeed in determining, by fossils hereafter discovered, some of the principal stages in its structure, and in thus relating its strata definitely to the great paleozoic divisions of our Appalachian geology."

Professor Agassiz expressed his great satisfaction at the announcement of Professor Rogers. Geologically speaking, its importance could hardly be over-estimated. We have now, he remarked, a standard level upon which to build up the formation of the metamorphic rocks. It also confirms the universal law, as elsewhere illustrated, of the creation and development of animal life.

Dr. Kneeland presented, in the name of Dr. Augustus C. Hamlin, of Bangor, Maine, very perfect casts of an inscription, supposed to be Runic, upon a rock on an island near Monhegan, Maine.

Dr. Jenks expressed his gratification at having at last an opportunity of examining so perfect a copy of the inscriptions in question. He had not, although he had been quoted as so doing, given any decided opinion as to their character. Copies had been transmitted to Copenhagen, and he hoped before long information would be received which would throw light upon these interesting inscriptions.

The thanks of the Academy were voted to Dr. Hamlin for his valuable donation.

Professor Agassiz made a few remarks upon the *Orthagoriscus mola*, of which he had recently had an opportunity of dissecting a specimen. This fish, which has been well described by Dr. Storer, and figured by Dr. J. Wyman in the Journal of the Boston Society of Natural History, has been placed heretofore in the same family with Diodon and Tetraodon. Professor Agassiz found that its internal structure was such as to be entirely incompatible with such a classification. The stomach he has ascertained to be directly continuous with the intestine, without any indication of difference, either in form, or structure of the mucous membrane; the whole tract resembling a long hose from one orifice to the other. He therefore considered it as the type of a distinct family, but want of time prevented his going into further details of its anatomy.

Professor W. B. Rogers gave an explanation of the causes of the motion of the Gyroscope, an instrument which is attracting considerable attention at the present time; ascribing the credit of its invention to the late Professor Walter R. Johnson of Philadelphia.

Four hundred and thirtieth meeting.

September 8, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Thomas B. Cary, Rev. George E. Ellis, Charles J. Sprague, and John B. Henck, accepting their appointment as Associate Fellows.

A circular was read from the Committee on the Inauguration of the Statue of Franklin, inviting the Academy to join in the procession on the day of that ceremony. It was accordingly voted, —

> "That the Academy accept the invitation thus politely extended to them; and that the Committee for placing the Statue be invited to make use of the rooms of the Academy as a place of rendezvous on the day of inauguration, Franklin himself having been one of the earliest Fellows of the Academy."

Dr. Durkee exhibited to the Academy a box of specimens of gigantic *Scarabœidœ* from the vicinity of Gaboon River, Africa; also specimens of *Platyphyllum concavum* (Katydid), of both sexes, obtained in Milton, Mass.; also *Spectrum femoratum.*

Professor J. Lovering read, in behalf of Colonel Emory, by title, a "Memoir containing the Results of Magnetic Observations not yet published; and combining the Results of all the Magnetic Observations made under my Orders in the United States and Mexican Boundary Commission. By Colonel W. H. Emory." This memoir was referred to the Committee of Publication.

Dr. Jenks read a highly interesting letter, written on July 21, 1781, by Dr. Richard Price, to President Joseph Willard, who was then Corresponding Secretary of the Academy. Dr. Jenks having stated that there was probably other valuable correspondence among the papers left by Mr. Willard, Joseph Lovering, Daniel Treadwell, and Francis Bowen were appointed a committee to confer with the descendants of Mr. Willard in regard to the publication of such matter as might illustrate the early history of the Academy.

Dr. Jenks also stated that he had received a communication from Dr. Hamlin, offering to obtain for the Academy the famous Dighton Rock, at an expense of not far from seventy-five dollars, and urging the expediency of the measure, on the ground that the inscription upon it is fast wearing away, and that its situation is such, being covered by every tide, that it is impossible to obtain an accurate cast of it in its present position. It was voted, —

"That the whole subject of the expediency of copying or transporting the rock be referred to a committee of three, namely, Dr. W. F. Channing, Dr. A. A. Gould, and Dr. C. T. Jackson."

Professor E. Horsford referred to the statement made at a former meeting, on the authority of Mr. Daniels of Wisconsin, that the bones of a fœtal child had been found in that country transformed into pure phosphorus. He exhibited a stick of phosphorus having a rude resemblance to the thigh-bone of a child, and which had been put in his hands as evidence of the statement. It was an ordinary stick of phosphorus, and could not have resulted from spontaneous decomposition of human remains. Mr. Horsford had calculated that the body of a child weighing ten pounds could not furnish more than an ounce of phosphorus.

Dr. C. T. Jackson expressed his concurrence in the remarks of Professor Horsford.

Four hundred and thirty-first meeting.

October 14, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. C. T. Jackson, from the committee appointed at the last preceding meeting to consider the propriety and practicability of removing Dighton Rock, read a letter from Dr. Hamlin of Maine, describing the present situation of this interesting antiquity, and giving urgent reasons for its removal, in order to the preservation of the inscription, which, it appears, is in such a position that it cannot well be photographed as it lies.

President Hitchcock joined in the recommendation, and gave some details respecting the position and nature of the rock, and the condition of the inscription, which, he argued, is likely soon to be obliterated, unless removed from its present situation.

Dr. O. W. Holmes exhibited a suite of Indian arrow-heads, or, most likely, spear-heads, found in the soil of his grounds at Pittsfield, arranged in a series so as to show all the stages of manufacture, from the natural piece of hornstone, slightly hammered, to the finished implement.

Dr. A. A. Hayes made the following communication : —

"*On the Change of Position among the Particles of Solid Metals, induced by the Action of Gentle but Continued Percussion of the Masses they form.*

"In calling the attention of the members to this subject, I will state that the chief illustration of some new points is to be found in the specimens exhibited; which show the gradation of action, dependent on time elapsing while the masses were exposed, in a distinct manner.

"The change by which malleable iron becomes converted into a highly crystalline metal, when subjected to pressure attended by a tremulous motion, as in the case of railway bars, has been often observed, and the attendant circumstances noted. My attention has been called to many cases, in which the same effects have followed a gentle percussive action on a part of a bar, the metal becoming changed at one point only, and hence — by chemical dissection the bar being laid open — the fibrous metal could be seen united to that changed portion, which had become highly crystalline and generally brittle.

"It is well known that the crystalline condition, assumed after the iron has been laminated to the extent of rendering it uniformly fibrous, is due to motion and change of place between the molecules of the iron, without the condition of softening or fluidity. The extreme cases often present us with a polarized condition, in which the crystallized iron is as perfect indeed as would have resulted from cooling a fluid mass in a state of repose.

"Malleable iron in its fibrous arrangement may be assumed as exhibiting its particles of broken-down crystals in a state of tension, in which certain physical conditions, such as specific gravity and resistance to strain, are insured while this state continues. A return to the normal or crystalline state requires only vibratory motion, in aid of natural polarizing forces always acting, to cause molecules to unite into regular solids and pass to a condition of repose, in which the masses become brittle. It is among the triumphs of modern science that a successful effort has been made to overcome the practical disadvantages arising from this disposition in malleable iron to become brittle; and in one of its most important applications — that of railway axles — this has been effected completely. The discovery by E. M. Connell, an English engineer, that the vibrations among the particles of *hollow masses* do not result in crystalline arrangements, has led to the adoption of hollow axles, in which uniformity of thickness of metal is insured, while only two thirds of the weight of the metal used for forming a solid axle is retained.

"An interesting case of the formation of large crystals under quite new conditions, in an alloy of which zinc forms the larger part, has recently been observed by me. This alloy, when rapidly cooled, presents a crystalline arrangement much like that of steel. When cast in the form of balls, in cold metallic moulds, it shows the effect of *chilling* remarkably. The metal forming the exterior becomes solid and more dense, while that in the interior conforming to it leaves a void of a spherical form, in each ball of an inch in diameter as large as a small pea. From well-known facts, we should have expected to find this cavity bounded by crystals or crystalline facets; which does not occur, but its inner surface always exhibits the flaws and irregularities observed when a metallic mass contracts in cooling from a fluid state. These balls were used for reducing saline bodies to powder in revolving cylinders containing several hundreds of them, and the conditions were such that the balls, impinging on each other at mere points as it were, received light blows over every part of their surfaces. It would perhaps be inferred that the diameters would have been reduced by the metal being forced into the void space as the effect of percussion. Instead of this reduction, the balls first became elongated pear-shaped, they then exhibited protuberances, and finally an elongated mammillary form, in which the diameter was one half longer than that of the original, while the whole bulk was increased from one to one and twenty-four hundredths.

" A careful examination of the surfaces showed that the uniformity of the indentations from impinging was constant, and the conclusion was, that the new forms assumed were in no wise affected by any inequality of this action.

" On breaking the specimens, the internal structure of each ball was nearly the same, *exhibiting an effort to form prismatic crystals radiating from a centre on one side of the void, while every particle seemed to have changed its place and made a new aggregation.* Where before the texture was small-granular, broad and brilliant-bladed crystals were found, with open interstices, while in the space originally void the terminal points of many crystals made it a geode in appearance.

" In offering an explanation of this extensive change among the molecules, I think we may consider the polarized state of the outer surface of the ball suddenly cooled as continuous in its action. The attraction of the interior molecules for this part is seen in the formation of a void space; and when the vibrations of impinging points induced a movement, the molecules united their dissimilar poles in the ordinary way of building up a crystalline aggregate. The natural crystal of this alloy being prismatic, room for the radiations which this form must exhibit would be found only by an enlargement of the exterior crust, which, owing to the slight degree of malleability in this case, occurred without fracture. Unequal aggregation of crystals formed would produce the concretionary and mammillary masses into which the balls were converted; and it seems probable that the taking on of this form was but one step in passing to one still more simple, in which the natural crystalline form of the alloy would have been presented in a single crystal."

Dr. Engelmann gave additional accounts of the peculiarities, classification, and geographical distribution of the *Cactaceæ* of the United States.

President Hitchcock exhibited a model representing the shape of the masses of snow which fell at Brattleborough, Vermont, on the 24th of May last. The masses were all alike, and in the form of a cone with a concave base, of about a quarter of an inch in diameter, and of a pretty firm consistence, — about that of an ordinary snow-ball.

Four hundred and thirty-second meeting.

November 12, 1856. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Professor Agassiz stated that he had recently been engaged in the study of a number of fishes of Greece, which he had received from his friend, Dr. Roeser, through the agency of Professor Felton, which led him to identify the Glanis of Aristotle.

"There are several classes of the animal kingdom, respecting the habits of which most of the information stored up in our scientific records is derived from the observation of men of little education engaged in the labors of common life. This is particularly the case with the fishes. The importance of fisheries at all times, and the value of fish as an article of food, have made it necessary for those interested to ascertain all that can be known respecting the habits of fishes, in order that they may the more successfully pursue their occupations. If we look over all the works on ichthyology written down to the present day, or any more general works in which the fishes are included, a critical reader will very soon perceive that the remarks relating to the habits of fishes are for the most part made on the authority of the fishermen. Cuvier justly says, that to his day no man knew the fishes of the Mediterranean more accurately than Rondelet, — that classic sea, surrounded from the most ancient times by civilized nations interested in fisheries, fond of fish as an article of food, carrying the luxury so far as to have them brought alive upon their table, to enjoy the beautiful sight of the changing of their colors in the struggles of death; and yet every page of his work shows that most of his information respecting the habits of fishes was borrowed from his intercourse with fishermen. The works of Aristotle furnish frequent evidence that his own information upon this class of animals, as far as their habits were concerned, had a similar foundation. But he, as all great naturalists of all times, sifted the reports, sought for more information where it seemed needed, and related only what he knew could be depended upon, however marvellous some of his statements may seem at first sight. There are many facts of this kind related in the works of Aristotle, which have excited considerable doubt, and even led to suspicions respecting the general trustworthiness of his assertions. There are a few passages in his works which have even been questioned more directly. Such is his mention of the habits of the Glanis, in the following passages: —

" 'The fresh-water fishes spawn in the still waters of rivers and lakes among the reeds, as the Phoxinos and the Perke. The Glanis and the Perke give out their spawn in a continuous string, like the frogs; and indeed the spawn is so wound up that the fishermen reel it off, at least that of the Perke, from the reeds in lakes.

" 'The larger Glanis spawns in deep waters, some at the depth of a fathom; the smaller in shallower places, especially among the roots of willows or some other tree, and also among the reeds, or the mosses. They copulate, sometimes a very large with a very small one, and bringing the parts together which some call the navel, and through which they discharge the seed, the females the eggs, and the males the sperma. All the eggs that are mingled with the sperma become generally on the first day white and larger, and a little later the eyes of the fishes become visible. These at first, in all fishes, as also in all animals, are early conspicuous on account of their size. And those of the eggs that the sperm does not touch, as in the case of the sea-fishes, are useless and sterile. But in these fertile eggs, as the fishes grow larger, a kind of husk separates. And this is the envelope that encloses the egg and the young fish. When the sperm has mingled with the egg, the spawn becomes more viscous among the roots, or wherever it may have been deposited. And where the greatest quantity is deposited, the male guards the eggs, and the female, having spawned, departs. The growth of the Glanis from the egg is very slow, wherefore the male keeps watch forty or fifty days, that the young may not be devoured by the fishes that happen to be in their neighborhood.' *

"'Of the river fishes, the male Glanis takes great care of its young. For the female, having brought forth, departs; but the male, where the greatest deposit of eggs has been formed, remains by them watching, rendering no other service except keeping off other fishes from destroying the young. He does this for forty or fifty days, until the young are sufficiently grown to escape from the other fishes. And he is known to the fishermen wherever he may chance to be watching his eggs; for he keeps off the fishes by rushing movements, and by making a noise and moaning. And he remains by the eggs with so much of natural affection, that the fishermen, when the eggs adhere to deep roots, bring them up to the shallowest place they can; but he does not even then leave his offspring, but if he chance to be a young fish, he is easily taken by the hook, because he snaps at all the fishes that approach him; but if he is already accustomed to this, and has swallowed hooks before, he does not even then desert his young, but breaks the hook by a very strong bite.' †

"Cuvier, alluding to these passages in the great *Histoire Naturelle des Poissons*, which he published in connection with Valenciennes, makes the following remarks respecting the fish called Glanis by Aristotle, and its habits: —

"'It cannot be doubted that our Silouros is the Γλάνις of Aristotle. Besides that it is common in Macedonia, and still bears in Turkey the name of *Glanos* or *Glano*, what the philosopher states concerning his *Glanis* agrees well enough with our Silouros, so far as we know its history; the disturbance that stormy weather causes him, the slow development of the eggs, their size, the care he takes of them, the noise he makes, &c.

"'It is possible that at a certain period the name Silouros, which Aristotle does not employ, may not have been the synonyme of Glanis. For in a passage of Ælian, where the Glanis of the Strymon [misprinted in Cuvier's work Shymon] is mentioned, the Glanis of Aristotle is compared with the Silouros. Perhaps this name belonged originally to some of the species of Egypt or Syria; but what is also very certain is, that, in another passage, Ælian applies this name to our Silouros of the Danube; and Pliny makes the same application, and even employs it in translating the very passages of Aristotle.'[*]

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* Aristotle, Hist. An., Lib. VI. c. xiii. §§ 2-6.

† Lib. IX. c. xxv. § 6.

"'What Aristotle relates in detail, and in two passages, of the care which the male Silourus takes of the eggs of the female, borders on the marvellous. According to him, the large Silouri deposit them in deep waters; the smaller among the roots of willows and other trees, among the reeds or even the mosses. The female, having laid them, leaves them, but the male guards and defends them; and as the *eggs are long in developing, he continues this care forty or fifty* days.'[†]

"Within the last ten years, much unexpected information has been collected by naturalists themselves, no longer borrowed from indirect observation, but ascertained while tracing their embryonic growth. Among these investigations, none has attracted so much attention as that of Coste, who observed that the Sticklebacks of Europe build a very neatly constructed nest, in which the eggs are deposited, the parents sitting upon and watching by them until the young are hatched. This fact, however, had already been noticed more than thirty years ago, and recorded in the Isis of Oken. Von Martens had made similar observations upon a species of Gobius, found in the Lagunes of Venice. But from want of sufficiently minute illustrations, these facts hardly attracted notice, until the full and extensive accounts of Coste, accompanied with numerous drawings, not only removed all doubt respecting the care which some fishes take of their progeny, but revived extensively the interest in such investigations.

"Since I have been in the United States, my attention has been particularly directed to this subject, again and again, by the numerous reports which have reached me, that there are in this country several species of fishes which take care of their young in a similar way, belonging to the genera Catostomus, Exoglossum, Pomotis, and Pimelodus. Of Exoglossum and Catostomus I have had no opportunity thus far to observe the habits with sufficient minuteness to ascertain which of the numerous species of the latter genus takes such care of its young, and in what way this is performed; but it is reported of Exoglossum, that they carry little stones to build heaps, among which the eggs are laid; and this species is commonly called *Stone-toters* (carriers of stone). But I have had ample opportunity to watch the Pomotis in the breeding season every spring for the last eight years. At that time it approaches in pairs the shores of the ponds in which it lives, and selects shallow, gravelly places, overgrown with *Potamogeton*, water-lilies, and other aquatic plants, in which it begins by clearing a space of about a foot in diameter, rooting out the plants, removing, with violent jerks of its tail, the larger pebbles, carrying away with its mouth the coarser gravel, and leaving a clean spot of fine sand, in which it deposits its eggs, surrounded and overshadowed by a grove of verdure as represented in the following wood-cut. In this enclosure one of the parents remains hovering over its brood, and keeping at a distance all intruders. The office of watching over the progeny does not devolve exclusively upon either of the sexes, but the males and females keep watch alternately. The fierceness with which they dart at their enemies, and the anxiety with which they look out for every approaching danger, show that these are endowed with stronger instincts than have been known heretofore in any of their class. Their foresight goes so far as to avoid the bait attached to any hook, however near it may be brought to them, and however lively and tempting it may be. *Pomotis* do not build their nest singly; hundreds of them may be seen along the same shore, within very small distances of one another, forming, as it were, temporary settlements, two nests sometimes hard by each other, or only separated by narrow partitions of water-plants. However near to one another, the pair of one nest do not interfere with those of another,

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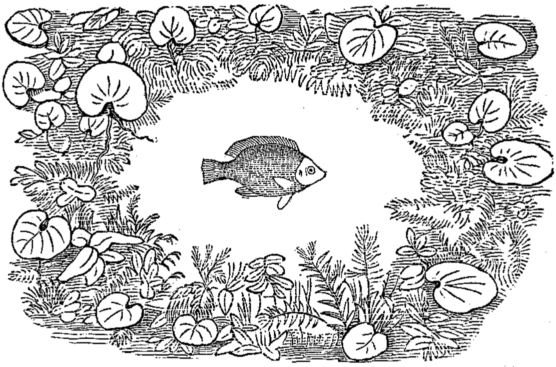
[*] Cuvier, Histoire des Poissons, Liv. XVII. c. 1, Vol. XIV. pp. 344, 345.

[†] Ibid. pp. 350, 351.



but like good neighbors they live peacefully together, passing over each other's domain when going out for food without making any disturbance. But whenever an unmated single fish makes its appearance among the nests, he is chased away like an intruding libertine and vagabond. The development of the egg is very rapid. In less than a week the young are hatched, and the parents soon cease to take any further care of them.

"*Pimelodus catus* I have had fewer opportunities to watch. However, I have seen them in the spring, which, in the latitude they inhabit, does not fairly set in before the end of May, approach the shores of our ponds, like Pomotis, in pairs, and clear also a space among the low water-grasses, scirpus, and the like, in very shallow water, not more than a foot or so in depth, and deposit its eggs in the same manner as Pomotis, and watch as carefully and vigilantly over its progeny. Yet I have not been able to ascertain how long the period of incubation lasts. But at different times I have seen the young already hatched, still hanging about within the area of the nest, protected by their watchful parent: sometimes the male and female remaining together with them; at other times, either one or the other of the old fish keeping watch alone. I have seen larger broods of young, already three fourths of an inch, and even an inch long, remaining together like a flock, around one or the other of the parents; and sometimes both swimming slowly in the centre or by the side of what, at some distance, would appear like a black cloud rolling slowly through the water in one or another direction, but which, seen more closely, proves to be a flock of young fish. I have observed such flocking broods through the whole month of June, and noticed that in each the young were of larger and larger size in the latter part of that month, until they swim more loosely, and finally disperse half together; the parents standing nearer the flock, or even in its centre, in proportion as the fish are smaller. When watching over the eggs which are not yet hatched, or when following the young brood, the old fish seem very solicitous for the safety of their progeny, and drive away with great fierceness any approaching enemy. I have even seen one dart at a little hand-net which I was dipping in the water, to secure the young which were still hovering over their nest.

"Having thus far become familiar with the mode of reproduction of Pimelodus, the statements of Aristotle relating to the Glanis of Greece, which is another representative of the same family of Siluroides, were brought back to my mind with increased interest. The correctness of the facts related by the great Stagirite respecting that fish could no longer be doubted, as soon as it had been ascertained that another member of the same family has habits so nearly similar to those of the fish of Hellas. There was, moreover, a particular charm in the prospect of confirming the reports of a philosopher of classic Greece, by investigations made in a country so recently covered with the primitive forest, and roamed over by the native tribes of Indians. I availed myself with eagerness, therefore, of the opportunity afforded by Professor Felton's visit to Greece to obtain, if possible, fresh-water fishes from that country, to ascertain by direct comparison what the Glanis of Aristotle really is. Though I had no longer reason to doubt the facts reported by the ancients respecting its mode of reproduction, I was not prepared to believe that Cuvier is correct in considering the Glanis as identical with the Silurus of Central and Eastern Europe, even though the opinion expressed by Cuvier is that entertained also by Pliny, and the naturalists of the Middle Ages; * for I have been acquainted with the Silurus from my boyhood; I was brought up on the shore of a lake where it is common, where fishing is practised on an extensive scale, and where I have myself spent weeks and months in the delightful, lazy, and enticing pursuit; and yet I have never heard nor seen anything respecting that Siluroid which could apply to the Glanis of Aristotle. I wrote by Professor Felton a letter to my old friend, Dr. Roeser, first physician to their majesties, the king and queen of Greece, requesting him to spare no efforts in procuring for me fresh-water fishes from that country, in the hope of thus obtaining the means of ascertaining by actual inspection the true character of the Glanis. Some time after, I received from Dr. Roeser a very fine collection of well-preserved specimens from the Eurotas, the Ache-

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* Ælian (Nat. An. XII. 14) does not confound the two: "The Lagnis (Glanis) is found in the Mæander, the Lycus, and other Asiatic rivers, and in Europe, in the Strymon; and resembles the Silurus in appearance. Of all fishes it has the most natural affection for its young. When the female has laid her eggs, she is relieved of all care of the young, like one in childbed; but the male, taking his post as the guardian of his offspring, stands by them, keeping off every assailant. He is capable even of swallowing a hook, as Aristotle relates."

Pliny (IX. 52), however, makes the mistake: "The male Silurus alone watches the eggs when laid, often even fifty days, that they may not be destroyed by others"; — thus transferring Aristotle's description of the Glanis to the Silurus of Central Europe.

lous, and the Spercheios, to which were appended labels with the local names under which they are known to the Greek fishermen at the present day. A more interesting collection than this I have seldom had an opportunity to examine. In it were half a dozen specimens labelled Γλανίδια (Glanidia), caught in the Achelous, the chief river in Acarnania, from which locality Aristotle himself had derived his information about the Glanis. The identity of the name and of the place leave no doubt that I am now in possession of the true Glanis of the Greek philosopher; that this *Glanis* is a genuine Siluroid, but not the *Silurus Glanis* of the systematic writers.* It is a distinct genus, closely allied to Silurus proper, of which I shall take an early opportunity to publish a detailed description, with figures, under the name of *Glanis Aristotelis*: and thus, though at this late day, vindicate once more the accuracy of the greatest naturalist of the ancient world.

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* The following quotations will sustain these assertions: —

"The Cordylus swims with its feet and its tail; and it has a tail like the *Glanis*." — Aristotle, Hist. An. I. 5. 3.

"Of those that have gills, some have simple gills and some have double; but the last, nearest the body, is in all cases simple. And some have few gills, others have many, but all have an equal number on both sides. Those that have the fewest have one on each side, but that double, as the Capros; others have two on each side, one simple, the other double, as the Conger Eel and the Scarus; others have four simple ones on each side, as the Elops, the Synagris, the Murœna, and the Eel; and others still have four, but in two lines, except the last, as the Kichle, the Perke, the *Glanis*, the Cyprinos." — Ibid. II. 9. 4.

"Of those belonging to the sea, and having lungs, the dolphin has no gall-bladder; but all birds and fishes have the gall-bladder, the egg-laying, the four-footed, and, to speak generally, sometimes more, sometimes less. But some of the fishes have it on the liver, as the Galeodes, the *Glanis*, the Rhine, the Leiobatos, the Narke; and of the lung fishes, the Enchelys, the Belone, and the Zygæna." — Ibid. II. 11. 7.

"The river and lake fishes are exempt from pestilential disease, but some of them have peculiar disorders, as the *Glanis*, which, about the time of the dog-star, by reason of swimming on the surface, becomes sun-struck, and is stupefied by loud thunder; and many Glanides in shallow water perish by the bite of snakes." — Ibid. VIII. 20. 12.

These passages show, that, — 1. The anal fin of the Glanis of Aristotle has the form of the Glanidia of the Achelous. 2. The description of the gill agrees equally with those of the specimens in my possession. 3. The presence of the gall-bladder in the position described is another point of agreement. 4. The connected spawn of the Siluroid differs from the isolated eggs laid by many other fishes, as, for instance, the Salmonidæ. 5. The swimming near the surface agrees fully with what is observed among Siluroids in hot weather. So every statement of Aristotle relating to his Glanis, either agrees with the structure observed in the specimens obtained from Acarnania, or, as far as the habits are concerned, with the mode of spawning of the North American Pimelodus, with perhaps the single exception, that the account of Aristotle is more minute than any statements that could at this moment be made respecting our fishes of that family.

The passages here given contain all that Aristotle has said of the Glanis.

" The great work of Cuvier and Valenciennes, *Histoire Naturelle des Poissons*, contains all that was currently known about the class of fishes up to the time of its publication. The learned authors of this extensive book, which, though unfinished, numbers not less than twenty-two volumes, have not only described all the fishes they could obtain themselves, but also sedulously collected all the information that may be gathered from earlier writers, and even referred the statements of the ancients relating to these animals to their respective species, as far as this could be done. That work is therefore as truly a model of scientific erudition, as it is a standard for all future investigations upon the class of fishes.

" These remarks are made chiefly with the view that I may not appear to disparage a scientific production which is destined to stand the test of time, because I happen to have it in my power to rectify some statements respecting the *Silurus Glanis* contained in that work.

" Strange condition of modern culture, which makes it possible for an inhabitant of the United States to contribute to the elucidation of the works of Aristotle, written more than two thousand years ago, and to vindicate the accuracy of that great naturalist by observations of a similar character made upon the inhabitants of the fresh waters of a continent, the existence of which was not even suspected by the Greek philosopher."

Professor Felton remarked, that he had some acquaintance with the fishes of Greece, but chiefly in other than their scientific relations. He rose, however, not to speak of science, but to make a few philological remarks.

" The communication of Professor Agassiz is extremely interesting in every point of view. It is a very striking fact, that the fish in question should, so many centuries after the death of Aristotle, have come from the Achelous across the Atlantic to this country, to furnish our associate with a commentary on the great philosopher, and to vindicate his accuracy as an observer against the criticism even of a Cuvier.

"There can be no doubt of the identity of this fish with that whose habits are described by Aristotle, under the name Γλάνις. The ancient names of birds, fishes, and quadrupeds, in numerous instances, are preserved among the common people, under forms modified in the same way as other classes of words are by the uneducated. The oblique cases are often used, as is common in other languages among the ignorant, for the nominative; in other instances, diminutives are formed from the roots, as exhibited in the oblique cases, and used in the sense of the original word. The name in Aristotle is written Γλάνις; the local name still preserved among the fishermen, in the *same region, in the North of Greece, is Γλανίδι, formed, according to* numerous analogies, from the genitive Γλάνιδος; and the plural of Γλανίδι (Γλανίδιον) is Γλανίδια, the word employed in the catalogue accompanying the specimens. Thus the fish sent from Acarnania to Athens, and from Athens to Cambridge, to find a place in Professor Agassiz's collection, though dumb, has spoken a noble eulogy upon the greatest philosopher of the ancient world.

"There is a close connection, as Cicero long ago observed, a *commune vinculum*, between all departments of learning. This instructive fish has not only corrected Cuvier, but the Greek lexicographers, who must take a lesson of him, and change their definition. Pape, who is generally very accurate, defines Γλάνις as 'eine Art Wels,' *a kind of cat-fish*, which is tolerably near the truth; and Liddell and Scott, the translators of Passow, call it *a kind of shad*. Hereafter the shad must give place to *horn-pout*, a substitution less displeasing to the lexicographer than to the epicure."

Dr. B. A. Gould acknowledged, in the name of Argelander, his election as Honorary Member, and offered as an apology in his behalf, for not directly addressing the Academy, his inability to write English with facility.

Dr. O. W. Holmes exhibited a section of a Hemlock which had recently fallen on his estate at Pittsfield. The section was made at the height of twelve feet, and by its rings showed its age to be at least three hundred and forty-six years, dating back to 1510. The section exhibited the usual inequality of growth at different periods in the varying width of its rings. Dr. Holmes made the specimen interesting, by indicating at different points the epoch of the birth and death of some of the great lights of English literature, comparing the existence of each with the few inches of growth of the tree, exhibiting in striking contrast the shortness of man's earthly career. Some conversation ensued on the popular notion that, under certain circumstances of external condition, more than one ring might be formed in a single year.

Professor Gray regarded all such opinions as erroneous, or at least not based on any reliable observations. So far as is known, in temperate climates, all ordinary woods make one annual ring; the fact has not as yet been determined so decidedly in the case of tropical trees. Young trees grow more rapidly and unequally than old ones, and hence an inequality in the width of the rings.

Professor Agassiz said that Mr. H. J. Clark had recently noticed that in the climbing Dogwood (*Rhus Toxicodendron*) the side of the branches resting on any opposing object becomes thickened by an increased development of the rings on that side.

Professor Gray said he had observed this unequal growth in the same plant in old stems of the plant, but had not noticed it as bearing any relation to any circumstances of position. Such anomalies are common in climbing plants, particularly in those of southern and tropical climates. Mr. Clark had shown him very young stems of Rhus, in which the same irregularity existed without any reference to position. The fact is, that, after the first year, the woody layer fails to be formed on one side of the stem, and that too on the free and convex side, not on that which is flattened by pressure against the supporting object, as would have been expected. Mr. Clark has promised to investigate this anomalous growth more particularly.

Dr. B. A. Gould stated, that in Texas it had been pointed out to him, that trees grow most on the south side; and the circumstance was depended upon at times by hunters to direct their path.

Professor Gray observed that such facts are well known, as trees habitually grow most on the side on which the most favoring influences predominate. On the sea-coast the trees naturally grow most freely on the land side.

The following gentlemen were elected Resident Fellows, viz.: —

Professor Henry W. Torrey of Cambridge, in Class III., Section 3.

Rev. N. L. Frothingham, in Class III., Section 4.

Benjamin A. Gould, in Class III., Section 2.

E. A. Sophocles, in Class III., Section 2.

Dr. C. H. F. Peters, in Class I., Section 2.

Henry James Clark, in Class II., Section 3.

Four hundred and thirty-third meeting.

December 9th, 1856. — ADJOURNED QUARTERLY MEETING.

The Academy met at the house of the President. The President in the chair.

The Corresponding Secretary read letters from the Rev. N. L. Frothingham, accepting the Fellowship; from the Imperial Academy of Sciences, Vienna, March 10th and April 15th, acknowledging the receipt of the Academy's publications; from the Zoölogical and Botanical Association, Vienna, May 10th; the Royal Society of Sciences at Upsal, November 16th, 1855; the Royal Prussian Academy of Sciences, Berlin, March 6th; the Natural History Association of the Prussian Rhine Countries and Westphalia, Bonn, January 12th; the Imperial Geological Society, Vienna, March 20th; the Imperial Academy of Sciences, Vienna, May 23d and July 16th, presenting their various publications; from the Society of Physics and Natural History, Geneva, March 11th, in acknowledgment of the receipt of the Academy's publications, and presenting its own, with a circular, offering the fifth annual botanical prize on the foundation of De Candolle.

The President read a paper on the probable cause and nature of the death of Pliny the Elder, taking the ground, in opposition to the commonly received opinion, that he died of apoplexy, and not of suffocation.

A discussion arising upon the nature of the effluvia, ashes, &c., emitted by volcanoes, Dr. Hayes remarked, that eruptions were of a mixed character, distinguished by lava overflows, sublimations, and chloridic and aqueous exhalations in some cases, while in others the presence of atmospheric air and vapor of water in large quantity gave rise to sulphurous acid fumes, and sulphydric gases, with sulphur depositions. Regarding the account of the death of the elder Pliny as remarkably explicit in details, he thought the statement in relation to emission of sulphurous fumes at that time as in accordance with present knowledge on this subject, and yet as in no wise opposing the interesting view which has just now been presented of the cause of his death. The abundant source of sulphur fumes and sulphydric gases is the solfa-taras, which, generally in action, exhibit during eruptions their highest activity; and these existed then, and now exist, in the low grounds in the vicinity of Vesuvius, changing their places as the decompositions on which they are dependent proceed. Solfa-tara action can hardly be classed with true volcanic action, although primarily dependent on it. It is a slow combustion, taking place among the aggregates formed at the time of previous volcanic action, requiring the presence of water for continuing it. The earliest history of Vesuvius presents it as a solfa-tara consuming the lava rocks of an earlier period, and its cones of later dates have been craters of elevation, subject to degradation, which has several times occurred. Pliny, at the time of his death, was at Stabiæ, where were hot volcanic waters along the shores, marking the points of solfa-tara action. The sulphur of commerce is derived from the deposits formed by solfa-taras, and its immense quantity affords some estimate of their extent and antiquity.

Mr. Everett followed, illustrating the changes in locality of the solfa-taras, from his own observations, after an interval of a few years had elapsed. He also stated as his experience, that the crevices of the lavas, in the vicinity of the crater of Vesuvius, emitted sulphur fumes; the napkin containing eggs, while being cooked, was coated with sulphur.

Dr. Pickering remarked, that, so far as his observations extended, sulphur vapors were abundant in lava crevices, wherever vapor was emitted. Referring to the great lava lake of the volcano of Hawaii, he said there was no perceptible smell of sulphur near its surface.

The President, Dr. Peters, and Professor Horsford also took part in the discussion.

The President expressed an interest in the question of the origin of volcanic ashes, referring to the fact of their being carried by winds and dispersed over extended areas at the time of eruptions; falling on vessels at sea far from any land.

In answer to an inquiry from the President as to the nature of volcanic ashes, Dr. Hayes replied, that they are the finely divided parts of broken down volcanic aggregates, having generally the composition of silicates of alumina, slightly contaminated by other silicates. To have a clear view of the origin of these ashes, it is necessary to consider that volcanic action, under its differing intensities, either fuses together or merely compacts assemblages of divers minerals, including sulphur compounds of metals and of earths. This action is often aqueous or hot-water action, and the rocks formed *include the elements of their own destruction*, on exposure subsequently to the air and moisture. Thus one of the most solid is the true Augitic Trachyte, which will not resist exposure to a New England atmosphere one year, without crumbling and disintegrating. Craters of elevation are composed in large part of this rock, often covered by true fused lavas in part. The latter, at the points near their source, are tolerably compact, but as they pass along the surface, they become tumefied and scoriaceous, and hence subject to decomposition. When the sulphurets have been engaged in the trachytes, decomposition commences soon after exposure to humidity, attended by the emission of vapors and acid fumes, which corrode and decompose all the superincumbent mass of rock, more or less. In craters of depression, as water can more copiously fall in, this decomposition of compound aggregates proceeds with great rapidity, and to great depths. The changes resulting from the chemical action thus established are not merely mechanical; salts more or less soluble form, and are dissolved in the escaping waters, while the rocky masses are reduced to their insoluble, finely divided, proximate elements. Few of the compound silicates resist this action; thus soda felspar, which generally is found in trachytes, and in the laboratory, decomposes slowly, but rapidly yields its silicate of soda to the acid and aqueous vapors, and solfa-tara is soon reduced to a mixture of silicic acid and pipe-clay. From this brief statement of facts, it becomes apparent that every volcanic focus becomes covered to a great depth with finely divided materials, resulting from rock decomposition, and any succeeding eruption must be preceded by a removal of this matter in the way of upheaval. The narratives of the eruptions of Vesuvius, so remarkable for graphic description, show that, after periods of repose, the first efforts of reawakened vigor are expended on the materials covering the surface. One of the most instructive examples, also, is that of the eruption, so called, of the volcano Morne Ronde, on the island of St. Vincent, in 1792, the marks of which I have examined. This, as is well known, is one of the volcanic vents of the Windward West India Islands, and its resumption of activity was preceded by no preliminary efforts. The inhabitants of the island were roused from their slumbers at about 2 A. M. by a terrific convulsion, the earth swaying under their feet, while the atmosphere, suddenly displaced, was rushing in opposing currents from all directions, attended by deafening reports. By one sudden explosion, the top of the mountain, about three thousand feet high, lost several hundred feet in height, while, as afterwards appeared, a cavity of about eight hundred feet deep was formed. The larger masses of the covering material rolled down its base, while the more finely divided part was carried upward, falling into the sea, — nearer or farther off in proportion to the size of its fragments. The finer parts rose above the current of the trade winds, and, taking the upper and opposite flow, spread over the sea and the island of Barbadoes, obscuring the light of a tropical sun, and causing the greatest consternation on land and sea. This ash I have examined from several parts of its course, and it differed in no respect from the fine parts of the trachyte, undergoing decomposition by atmospheric agents on the spot. There followed after this explosion no flow of lava, but a shower of rude balls of half-fused, tumefied trachyte, succeeded by fragments of rocks, earths, and finally mud and water. The final action took place obviously within the crater, formed more than eight hundred feet below the surface of the top of the mountain, and resulted in the production of a regular cone of sand and gravel, which remained. Twenty years after (1812) a similar explosion took place, and the point of greatest interest is, that a new centre of action appeared. A smaller crater was formed, so near the older one that the rim of the later one breaks its continuity. The action which followed the dispersion of the disintegrated covering in this case was of a kind among the most remarkable on record. A large part of the force was expended in discharging from the crater rocks broken into fragments, from the size of a cubic inch to that of grains of sand; nearly every fragment and grain being bounded by straight lines, square or rectangular, with sharp angles and edges. As the volcanic vents of the West Indies, and indeed whole islands, have been elevated from below a deep ocean which surrounds them, they offer the best examples of that secondary effect, resulting from chemical action taking place within the aggregates formed, which I could adduce.

Professor Horsford suggested that, as the volcanic ashes are silicates of alumina, it might be possible for the mixed chlorides of aluminium and silicium to be shot as a bolt from a crater, and at a distance from that point find moisture and atmospheric oxygen to convert them into oxides and hydrochloric acid; when they would unite to form silicate of alumina.

Dr. Hayes replied, that, if such a supposition were for a moment entertained, the mixed chlorides could only form hydrochlorates under the conditions, and if the mixed metallic bases were to be oxidized in union, a crystallized silicate of alumina would result, while volcanic ashes under a microscope are either scales with rough imbrications, or feathery forms, such as we every day see in decomposing trachytes and micaceous rocks, water being present.

In reply to the President, Dr. Hayes added, that the chloridic sublimates are not true chlorides usually, but hydrated compounds which do not form solid crystals, being transported in a vesicular state by watery vapor, which, with atmospheric oxygen, is always present in the gases evolved during the most active eruptions; hence true chlorides, excepting common salt, are rarely found.

Dr. A. A. Hayes made the following communication, "On some Points of Chemical Interest, connected with the Manufacture of Ductile Iron by the new Process of H. Bessemer," and exhibited some specimens.

"In calling the attention of the Academy to a part of the process for obtaining nearly pure ductile iron from crude products of the iron-ore furnace, which has of late excited much interest among those engaged in the iron manufacture, it is not my intention to enter upon the economical or technical part of the subject at this time. It is well known that Mr. Bessemer has based his improvements on the startling novelty of making crude iron nearly pure, *without the aid of fire from carbonaceous matter*. In considering the ordinary mode of refining crude iron, the final operations being performed on crude pig, or on partially refined pig-iron, we have as one of the conditions of success the application of an intense heat, and the presence of more or less atmospheric oxygen, necessary to maintain the required degree of fluidity in the mass of iron, and to burn out the carbon and other impurities present. As the iron loses its carbon and other extraneous substances, it becomes less fusible, and the workman, stirring the mass as it begins to lose its fluidity, gathers into rough masses the aggregated particles, which are always spherical in general form. From the masses, which are very porous and unequal, a bar of regular form is obtained by the usual means of pressing, or hammering and rolling.

"There is in this process strictly a segregation of particles of pure iron from the crude mass, which, under the agitation of stirring, unite to form rounded aggregations, and the heat of the furnace being increased, the separation of pure iron continues, until the melted impurities alone remain. The change of crude to pure iron is accompanied by the *production* in part of the impurities which remain; they are not educts. Aside from the loss of carbon in the form of carbonic oxide, the phosphorus and sulphur, — which my experiments have proved are always united to the metallic bases of the earths or alkalis, — with these bases, burn into oxidized products; while the silicium and a portion of the iron, also oxidized, form the melted slag, or cinder, as an additional foreign matter. To the loss of impurities we must also add the weight of iron burned in forming secondary products, so that, if the operations were performed on crude iron containing ninety-two per cent of pure iron, no more than eighty-two per cent of malleable iron will be obtained. By the method of Bessemer, crude iron in a melted state is exposed in a nearly closed receptacle to jets of air forced into and under the fluid, and it is alleged that such an excess of heat is produced in the process, 'that the metal continues to boil even after the blast has ceased.' The direct statement is made, that 'the air, dividing into globules, and diffusing itself among the particles of fluid iron, and thus coming in contact at numerous points with the carbon contained in the crude iron, and producing thereby a vivid combustion,' and the same action is implied in other parts of Mr. Bessemer's patent-specification.

"Now it is well known to chemists, that the combustion of the carbon of crude iron *cannot take place under the conditions.* This carbon exists in gray iron in the allotropic state of graphite, and is not combustible even alone, when exposed highly heated to a current of atmospheric air. We burn it in the laboratory by the application of oxygen in some condensed state only. The proper chemical explanation of this point is a very simple one. Iron, which is a highly combustible body at ordinary temperatures, has its attraction for oxygen enormously increased by the heat of fluidity, and in combining with this element, the heat disengaged is ample for carrying the temperature of the mass still higher. A portion of oxide of iron being formed, the mechanical motion imparted by the jets of air favors the contact of the oxide with the carbon, *which then burns with the condensed oxygen of the oxide of iron.* The products of this combustion, arising from the mingling of oxide of iron and graphitic carbon and pure graphite, are two, — pure iron, and carbonic oxide; the former uniting with the mass, the latter escaping as gas, and burning in the atmosphere, or even with any oxide of iron it meets with in the mass. A moment's consideration of the operation shows that the combustion of the iron at the first stage leads to the separation of the carbon as carbonic oxide, and a reduction of the oxide formed to pure iron. Silicium, phosphorus, cyanogen, and sulphur, the bases of the alkaline earths, and interposed slags are oxidized and removed as fusible compounds in the same way, *while the pure iron assumes the crystallized state.* The combustion of the iron raises the temperature of the acting bodies far above the initial point, while the reduction of the oxide of iron formed diminishes in a corresponding degree this temperature. Were the conditions of the experiment such that the oxide formed from the iron burned was equivalent to converting the carbon into carbonic oxide only, at the moment the oxide of iron became pure iron, then no increase of temperature would be noted, and the cooling influences of the surrounding medium would cool the acting bodies below the initial temperature. Hence, it is essential that more than an equivalent of iron should be burned, and a loss of this substance must take place, so that the operation of purification by the new process is carried on by substituting *iron as fuel* for carbon consumed in the ordinary process. Assuming six pounds of carbon to exist in a sample of crude iron containing ninety-two pounds of pure iron in one hundred pounds, then *twenty-eight pounds of iron* must be burned to oxide, and the six pounds of carbon will exactly reproduce the twenty-eight pounds of iron, leaving ninety-four parts of iron deprived of carbon. But the practical result differs from this statement, inasmuch as a positive loss of at least ten pounds of iron occurs; and in explaining the increased elevation of temperature, we neglect that portion of the iron which, having been burned and again reduced, adds to the mass, and keep in view the effect of the combustion of ten pounds of iron lost in the operation at the high temperature attained. Accurately, some addition to the temperature is made by the combustion of other bodies present besides carbonic oxide, but there are also sources of expenditure; leaving as useful effect the amount of heat generated by ten pounds of iron burned, from every one hundred pounds of melted iron taken.

"I believe this combustion, going on momentarily with the reduction of the oxide, is sufficient to afford the excess of heat required to maintain the temperature of the mass of iron above the initial temperature for the short time of thirty or forty minutes, during which the conversion takes place in a nearly closed vessel.

"The other point in this connection is the condition of the pure iron at the moment of its conversion. As this is most important to a correct conception of the practical bearing of the method, it was deemed necessary to describe briefly the ordinary mode of puddling iron, and reference is now made to that part where it is stated, that, as the iron becomes pure, it is less fusible.

"In ordinary, this less fusible part is 'gathered,' and forms 'puddle-balls'; if not thus removed, and time sufficient were allowed, the whole charge would become consolidated, and could not be removed. In the new method, the jets of air agitate or 'boil' the fluid iron, and yet this solidification does not proceed, and it has been assumed that the acting temperature is so high that the pure iron becomes fluid. No evidence has been presented to sustain this assumption, and it has been shown above, that there is no source of heat present adequate to cause such fluidity. All the specimens of a suite illustrating the manufacture, prepared under the eye of Mr. Bessemer, show that such heat of fluidity is unnecessary." (Dr. Hayes exhibited these specimens, which illustrated, step by step, the conversion of crude iron into pure iron, and the subsequent production of the interwoven particles forming wrought-iron, and the most finished specimens of laminated sheets.)

"These specimens prove that the molten mass of pure iron is not a *liquid iron*, but a semi-fluid composed of crystals of pure iron, which, in accordance with the laws of crystallization, have withdrawn from the fluid, merely wet by the fluid iron present, and rendered pultaceous by the carbonic oxide gas entangled. This physical condition of the iron is represented by particles of hail mixed with a small proportion of water, or more exactly by the mixture of crystals of sugar and concentrated sirup, as it is filled into the forms; such a mass will flow and take sharp impressions in the moulds, while its texture on cooling is highly crystalline and porous. Although the iron in this state is as pure chemically as any bar-iron, its mechanical state does not assimilate it to malleable iron, and the ingots rarely present the compactness of cast-iron of the coarser qualities. A careful examination of the specimens suggests the conclusion, that much of the character of fluidity is also due to the presence of the engaged carbonic oxide, which, like any gas disengaging from a dough-like semi-solid, causes it to flow.

"This mechanical constitution of the pure iron removes the difficulty which every iron-master must have conceived to exist, in the descriptions of the new method heretofore published, and it will be seen that the effects produced in the old and new process are strikingly similar; while the fuel in the one case is iron, in the other the ordinary coke or coal. In removing the iron from the furnace, the puddler depends on forming a rude porous aggregate, while Mr. Bessemer, by a refined mechanical agitation, converts the whole into a semi-solid, crystalline mass, full of gas-bubbles, which flows from an inverted vessel, and takes the forms of the moulds."

Mr. Charles Jackson expressed a doubt as to the practical value of the new process, and adduced the significant fact, that it had not in the least affected the price of iron in the market, nor the value of iron-works.

Dr. Hayes rejoined, that he had presented to the Academy, only the interesting chemical points, avoiding the economical bearing of the discovery. He was, however, prepared to discuss this fact, in view of its importance to the English, rather than to the American manufacturer.

Professor Gray presented, in the name of Dr. Engelmann, the following

"*Corrections and Additions to the Synopsis of the Cactaceæ of the United States.*

"On p. 279, the var. *minor* of *Cereus dasyacanthus* should be cancelled, and after *C. longisetus*, p. 280, the following added:—

"9½. C. Rœtteri, E. in B. C. R.: ovato-cylindricus, 10–12 costatus; areolis ovato-orbiculatis; aculeis e basi bulbosa subulatis-rubellis apice obscuris exterioribus 10–15, interioribus 2–5 robustioribus sub-brevioribus; floribus subterminalibus magnis purpureis; bacca subglobosâ; seminibus tuberculatis.

"El Paso, southward to the Sandhills; fl. April. — Stem 5–6 inches high; spines 4–8 lines long; flower 2½–3 inches long. Similar to *C. dasyacanthus*, from which it is distinguished by the fewer ribs, fewer and stouter spines, purple flowers, smaller fruit, and larger seed. This species is intermediate between the *Pectinati* and *Decalophi*.

"After *Opuntia setispina*, p. 294: —

"O. Pes Corvi, Le Conte, Mss.: articulis parvis teretiusculis; pulvillis subconfertis setas paucas breves graciles flavidulas gerentibus plerisque armatis; aculeis binis ternisve gracilibus sæpe basi compressis tortisque; flore flavo minore.

"Sandy coast of Georgia, *Major Le Conte*, and Florida, *Dr. Chapman*. — Joints not much over an inch long, and half as thick. Spines 1–1½ inches long, straight and slender. Flower 1½ inches in diameter. Ovary only with 5 areolæ; stigmas 5. — In the shape of the joints this curious little species resembles *O. fragilis*, but in other respects it seems intermediate between *O. vulgaris* and *O. tenuispina*."

Professor Agassiz addressed the Academy on the general characters of Orders in the classification of the animal kingdom. Orders, he said, are natural groups characterized by complication of structure. There are groups, however, constituting orders, which do not come under this definition; hence he concludes that the different classes of the animal kingdom do not all admit of the same divisions. Professor Agassiz illustrated his views by the different orders of Echinoderms. In conclusion, he remarked, that orders are of different kinds, some synthetic, some prophetic, others graduated.

After nomination by the Council, —

Laurens P. Hickok, D. D., President of Union College, Schenectady, was elected an Associate Fellow in the Section of Philosophy and Jurisprudence.

Dr. George B. Wood and Dr. Isaac Hays, both of Philadelphia, were elected Associate Fellows in the Section of Medicine and Surgery.

John Stuart Mill, of London, was elected a Foreign Honorary Member in the Section of Political Economy and History.

Manuel J. Johnson, Director of the Radcliffe Observatory, Oxford, was elected a Foreign Honorary Member in the Section of Practical Astronomy and Geodesy.

Four hundred and thirty-fourth meeting.

January 13, 1857. — MONTHLY MEETING.

The Academy met at the house of the Hon. Robert C. Winthrop. The President in the chair.

The Corresponding Secretary read letters from Dr. George B. Wood, Dr. Isaac Hays, and Laurens P. Hickok, accepting Fellowship; from the Essex Institute, the American Antiquarian Society, the Royal Institution of Great Britain, the Society of Arts, Manufactures, and Commerce, Professor Faraday, and Sir Charles Babbage, acknowledging the receipt of the Academy's publications; from the American Oriental Society, acknowledging the same, and presenting Vol. V. No. 2 of its own Journal; and from the Société Nationale d'Agriculture, &c. de Lyon, and the Académie Nationale des Sciences, &c. de Lyon, presenting their publications.

Professor Agassiz reminded the Academy of the recent death of a distinguished associate in the following words: —

"It is the first time we meet since the death of the Hon. Francis C. Gray, one of our fellow-members. Though there are others longer acquainted with Mr. Gray than myself, who are better qualified to speak of his general merits, allow me to take this opportunity to make known to you some incidents relating to the last objects upon which his mind was seriously engaged. I have not had the happiness of knowing Mr. Gray intimately for many years; but for the last two years peculiar circumstances, which are among the most fortunate of my life, have brought me gradually nearer to him, and enabled me to become more closely acquainted with his extensive attainments, and the great powers of his vigorous and clear intellect, and to appreciate fully the kindness of his feelings, and his unbounded benevolence.

"There is hardly any field of intellectual activity which did not engage at some time or other his inquisitive mind. But among the many objects to which he has turned his attention, there is one topic which particularly deserves to be noticed on an occasion like this, when the members of the Academy must feel that they have sustained a severe loss by his departure. Taking, as was his habit in everything else, a broad view also of the events of the day, he had satisfied himself that there is no field in which young men of ability could seek for a better opportunity of doing good service to their country, than in the pursuit of science, literature, and the arts. And this subject was one to which he returned constantly in conversation for the whole past year. Early in 1856, he was invited by the Regents of the University of the State of New York to deliver an address in Albany, on the occasion of the inauguration of the Geological Hall. His sickness unfortunately prevented him from attending the celebration. The subject he had selected for the occasion was that of his constant thoughts. He hoped to make an impression upon the community by an earnest appeal to the rising generation in favor of a deeper and more thorough cultivation of the learned vocations, and especially of science. No one among us was better prepared than he to set forth the great importance and the true dignity of such pursuits. He never tired of repeating that he considered intellectual and moral culture as the object worthiest of the highest ambition. It was not, he used to say, by prowess of arms, or by wealth, that nations could in future take a high standing among civilized communities, but by their devotion to, and their appreciation of, the higher interests of science, literature, and the arts. I need not say, that with him these were not idle words. I deem it my duty, as it is my pleasure, to refer to the great exertions he made, for a number of months in succession, to render possible the publication of my Contributions to the Natural History of the United States, and I truly lament that he did not live to see at least the first volume completed. But his great heart had higher aims than the personal success of a friend. He had conceived the plan of a great institution, devoted chiefly to the study of Natural History, in its widest ramifications, which should in course of time be for this country what the British Museum and the *Jardin des Plantes* are for England and France. He spoke repeatedly of the part he would take himself in fostering such a plan, and his will bears testimony to the importance which he attached to the establishment of such an institution. When he felt his strength failing him, he lamented his inability to make an energetic appeal to his friends for such a purpose. He thought, if he could go only once more into the streets, he might effect something towards this end worthy of the country. The last time he spoke to me upon the subject, was to hint at the possibility and the means of carrying out this great plan. The emotion with which he spoke is still fresh in my memory, and will accompany me through life, as an evidence of the fervor with which a truly noble mind may be occupied with the highest interests of his fellow-men, in a moment when he feels himself already at the threshold of another world.

"I beg to offer the following resolution: —

"*Resolved*, That the American Academy of Arts and Sciences have sustained, in the death of their late Associate, the Hon. Francis C. Gray, a loss not easily to be supplied. He was a man of vigorous mind, of large and liberal culture, of generous devotion to all good and noble objects, and a true friend."

The Hon. Josiah Quincy expressed his hearty concurrence with the sentiments expressed by Professor Agassiz, and referred to his own long acquaintance with Mr. Gray, in public and private, in terms most eulogistic and friendly. In conclusion, he moved that the resolution offered by Professor Agassiz be adopted, and that a copy of it, with the prefatory remarks, be printed in the public newspapers. The motion was seconded by Professor Treadwell, and adopted unanimously.

Mr. Sherwin read a paper on a new theory of parallel lines.

Mr. Folsom laid upon the table two manuscript pamphlets, containing interesting memoranda of early meetings of the Academy, &c., which he had found among rubbish in the Athenæum. He regarded them as objects of much value, and, in conclusion, moved that they, with such other loose papers of the Academy as may be worth preserving, be suitably bound, and placed in the Library of the Academy, and that a committee of four be appointed to attend to the matter. It was voted accordingly, that Messrs. Folsom, Bowen, Felton, and the Librarian be a committee for this purpose.

Professor Horsford read the following paper, "On the Oleic Acid Series of Fatty Acids," by George C. Caldwell, B. S., Ph. D.

"The fatty acids obtained from the various animal and vegetable fats that occur in nature, it is known, are divided into two principal classes.

"The one class forms a part of the series of acids constituted according to the formula $C_n H_n O_4$, while the other class forms the series with the formula $C_n H_{n-2} O_4$. The former series is by far the more completely developed, there failing but a few members, from formic acid, $C_2 H_2 O_4$, up to arachinic acid, $C_{40} H_{40} O_4$. As we pass from one acid to another in this series, there is a gradual change in the properties of successive acids, corresponding to the change in the formula, — a change which is exhibited more especially in the boiling point of those acids which can be distilled undecomposed, or in the melting points of those that cannot be.

"The other series is much less extensive, only the following members being yet known: —

Brassinic acid	$C_{45} H_{43} O_4$
Erucaic acid	$C_{44} H_{42} O_4$
Döglingic acid	$C_{38} H_{36} O_4$
Oleic acid	$C_{36} H_{34} O_4$
Hypogæic acid	$C_{32} H_{30} O_4$
Moringaic acid	$C_{30} H_{28} O_4$

"Also, in this series we observe none of that perfect correspondence between the formulæ and properties of different acids in relation to one another.

"This latter series being at the present time rendered an object of more special interest by the discovery of a new member, we give here a short account of the series in general, in connection with the result of investigations on this new member, which its discoverer, Dr. A. Goessmann, afforded us an opportunity of making, in the laboratory of Professor Wöhler in Göttingen.

"The oleic acid, the principal and best-known member of this series, was discovered by Chevreul, and its characters were subsequently completely developed by Gottleib. It is a solid fat at low temperatures, but melts at 16° C., and then oxidizes very readily in the air, thereby becoming changed to a reddish-yellow oil. Two very characteristic properties of this acid are as follows: —

"First. Under the influence of nitrous acid gas, it is transformed into an isomeric modification, not oxidizable in the air, and possessing a higher melting point than the oleic acid itself.

"Second. On dry distillation, it yields sebacic acid, among many other products.

"These properties being so characteristic and peculiar as they are, we might expect to find them with other members of the series; but the sequel will show that such is the case only in part.

"The oleic acid is very widely diffused, forming, as it does, a constituent of all the more important animal fats, and of most of the vegetable fatty oils. In a few cases only is it replaced by other acids constituted according to the same general formula.

"The *döglingic acid*, $C_{38} H_{36} O_4$, was discovered in a fat obtained from a species of dolphin. This acid is likewise solid only at low temperatures. Under the influence of nitrous acid, it undergoes a change; but whether an isomeric acid is produced is not yet known. Neither has it been determined whether it yields sebacic acid on dry distillation.

"The *brassinic acid* is found in the rape-seed oil. It melts at 32 – 33° C., is changed in the air when heated to 100° C., and is very soluble in alcohol, as are all the members of this series. An isomeric modification results from the action of nitrous acid.

"The *erucaic acid*, $C_{44} H_{42} O_4$, is found in the fatty part of the white mustard. It melts at 34°, and is very soluble in alcohol. Farther than this, we know nothing concerning its properties.

"The *moringaic acid* was found in the poppy oil. It has been but little studied.

"Finally, the hypogæic acid, which has formed the subject of our investigation, is a constituent of the oil obtained from the fruit of the African plant, the Arachis hypogæa, which is known in commerce as the ground-nut or pea-nut.

"To obtain it, the lead salt is first prepared from the crude mixture of the acids which occur in the oil, according to the ordinary method of preparing oleate of lead. This lead salt, on decomposition with a mineral acid, yields a reddish-yellow mass, which, at common winter temperatures, is a mixture of a reddish-yellow oil, and a white crystalline substance; the latter is the pure acid, the former the product of oxidation by the air. From this mixture the pure acid can be obtained by combining the whole with baryta, repeated recrystallization of the product from an alcoholic solution, and decomposition of this pure salt with a mineral acid. Thus purified, the hypogæic acid forms a white solid fat, which melts at 34° C., and then readily oxidizes in the air, precisely as is the case with oleic acid. The hypogæic ether, and the copper and baryta salts possess the same properties as the corresponding compounds of oleic acid.

"In order to determine the result of the action of nitrous acid on this acid, we instituted the following experiments.

"A portion of the acid, partly oxidized by the air, was slightly warmed to render it completely fluid, while a rapid current of nitrous acid gas was conducted through the liquid. The product, after being allowed to stand a week in a well-closed vessel, yielded, on recrystallization several times repeated, an acid which melted at 37 – 38° C., was unchangeable in the air, and very soluble in alcohol, separating from the solution in a crystalline form.

On analysis, the following results were obtained: —

	Calculated.		Found.	
C_{32}	75.59	75.41	75.57	75.59
H_{30}	11.81	12.01	11.91	11.89
O_4	12.60			

"Hence this acid is an isomeric modification of the hypogæic acid; we have proposed for it the name of Gæidinic acid.

"*Gæidinic ether* is a colorless oil, soluble in alcohol and ether, which solidifies at low temperatures, and can be distilled without decomposition.

"*Gæidinate of potassa* is easily soluble in water and alcohol, and can be obtained in pearly crystalline scales.

"*Gæidinate of baryta* is a white powder, insoluble in water, more soluble in alcohol.

"*Gæidinate of copper* is a green powder, with difficulty soluble in water or alcohol, which melts before decomposition.

"*Gæidinate of silver* is a flocky precipitate, insoluble in alcohol or water, soluble in ammonia, and which is readily blackened on exposure to the light.

"On comparison of this new acid with elaidic acid, the product of the action of nitrous acid on oleic acid, we find a perfect correspondence in their properties, and also that the relation between the properties of hypogæic and gæidinic acids on the one hand, and oleic and elaidic acids on the other, is quite similar.

"The oleic and hypogæic acids are both, as we have seen, readily oxidized on exposure to the air, as are also the ether compounds; and farther, neither the acids themselves, nor their ether compounds, can be distilled without decomposition.

"On the other hand, the elaidic and gæidinic acids are both unchangeable in the air, as well as their ether compounds. And they and their ether compounds can be distilled without undergoing decomposition. These acids also possess higher melting-points respectively than the oleic and hypogæic acids, although we observe here the remarkable distinction, that, while accompanying the transformation of oleic acid into elaidic acid there is an elevation of 31° C. in the melting-point, the same transformation of hypogæic into gæidinic acid produces a change of but 4° C. in the melting-point.

"The correspondence between the gæidinic and elaidic acids is also further established by the relation between their melting-points. They differ by $C_4 H_4$ in constitution, and their melting-points differ by about seven degrees. As Heintz has shown in regard to the other series of fatty acids, a difference of from 7° – 10° C. in the melting-points corresponds to a difference of $C_4 H_4$ in constitution; this rule holds good within certain limits so far as the melting-points have been accurately determined.

"These results, then, show that, under the influence of nitrous acid, hypogæic acid behaves in a manner precisely similar to that which characterizes oleic acid under the same circumstances.

"Farther, as the results of our investigation have proved, sebacic acid is one of the products of the dry distillation of hypogæic acid. Thus, that correspondence between the characteristic properties of these two acids which we should have a right to expect with two bodies standing near to one another in the same series, does not fail to hold good in every important respect. And this result is interesting, as no other member of this series of acids which has yet been discovered has yielded such satisfactory results.

"It is to be hoped, that further investigation on this series may develop a more complete correspondence between its members; for, as they now stand, there is hardly sufficient resemblance in their properties alone to suggest a classification of all of them together. The principal reason for this classification being founded in their constitution alone."

Professor Agassiz said, that, in the course of his recent studies of the Turtles, he had been anxious to ascertain whether the different stages of embryonic development, and the different orders of this class, corresponded with the different stages of geological succession. He was satisfied that the tracks in the Potsdam Sandstone and the Trias, attributed to these animals, were not made by them. The earliest remains of Turtles were found in the Jura, and they are of the fresh-water type. Now the order of position among Turtles places marine types lowest, next fresh-water, and last land Turtles. There was a want of correspondence with the geological succession. From the descriptions of these specimens, and his own recollection of them, however, Professor Agassiz was satisfied that these fossils present a synthetic type, like the Crinoids among the Radiata; showing characteristics belonging to several types. A similar instance he had found among the living species of South American Turtles, from Brazil, the Podœnemyds; which, although belonging to the fresh-water type, yet present certain characters in the formation of the temporal region very similar to those of marine species, constituting a true synthetic type. Professor Owen obtained from the Chalk the next geological species which had been discovered, and they belong to the Chelmians, with some characters of the marine species, but not the general form, — another synthetic type. Professor Agassiz did not regard these forms as presenting true exceptions to the law of correspondence between geological succession and the grade of development in living species, but only as evidence of the existence in past ages, as well as the present, of what he had called *synthetic types.*

Professor Horsford announced a new and convenient method of determining the value of saltpetre for the manufacture of nitric acid, by ignition with sal ammoniac.

Four hundred and thirty-fifth meeting.

January 28th, 1857. — STATED MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from Manuel J. Johnson, of the Radcliffe Observatory, Oxford, accepting his election as Foreign Honorary Member.

Hon. Robert C. Winthrop exhibited a piece of the submarine telegraph cable, by which it is proposed to connect Europe with America.

Dr. Hayes remarked, that the copper wire in the centre, with its gutta-percha envelope, will be protected from all action of the salt water by the sulphurizing action of the sea. This would convert the outer layer of iron wire with which the cable is invested into an impervious sulphuret of iron.

Dr. Charles T. Jackson exhibited a terrestrial globe, showing by colored sections De Beaumont's *Reseaux Pentagonales*, by which he explained his theory of the elevation of mountain chains.

Professor Agassiz commented upon De Beaumont's theory as being extremely beautiful and ingenious; in it the whole earth is likened to an immense crystal, formed by the cooling of the heated mass, the mountain ridges appearing on the lines of greatest resistance to shrinkage. He stated, that there was a singular coincidence between the number of distinct systems of Fauna, as made out by naturalists of the present day, and the geological systems of De Beaumont. These are each from fifty-five to sixty in number.

Dr. Hayes exhibited specimens illustrative of his remarks at the previous meeting on the action and products of volcanoes.

Dr. Holmes said that he had recently observed an unusual anatomical fact, viz. the power of voluntary motion of the ear in a man. This is of extremely rare occurrence. The individual in question was able to draw backwards and upwards either or both ears, with considerable force, to the distance of from a quarter to half an inch; and this was a natural movement whenever he listened intently.

In answer to an inquiry from Dr. Holmes, Dr. Hayes explained the action of gas stoves in the generation of heat.

The following gentlemen were elected Resident Fellows, viz.: —

J. Lothrop Motley, Esq., in Class III., Section 3.
Hon. Charles Francis Adams, in Class III., Section 4.
Hon. George S. Boutwell, in Class III., Section 4.

Four hundred and thirty-sixth meeting.

February 10th, 1857. — MONTHLY MEETING.

The Academy met at the house of the Hon. Nathan Appleton. The President in the chair.

The Corresponding Secretary read letters from J. Lothrop Motley and Charles Francis Adams, accepting Fellowship, and also one from J. Stuart Mill, in acknowledgment of his election as Foreign Honorary Member.

Professor Agassiz exhibited a cast of a fossil shell, recently obtained at Santa Fé de Bogotá, which he had just received from Paris. The specimen was remarkably perfect, and belonged to the genus Chryoceras, which has been referred to the family of Ammonites. It is an interesting question, bearing upon the law of correspondence of geological succession and order of position in living races, To what order of the Cephalopoda do the Ammonites belong?

Professor Agassiz proceeded to point out the characters of the two great divisions of the class, the Acetabulifera and the Tentaculifera, showing that there are characters in certain species of each which resemble those of species in the other class. He did not regard the position of the Syphea in the chambered shells, whether dorsal or central, as of much consequence as a distinctive feature, but rather its relative position. The fact of its being central or dorsal depended merely upon the animals being coiled one way or the other. Among the Gasteropoda, examples of reversed shells are well known.

In conclusion, therefore, Professor Agassiz was inclined to refer the Ammonites to the class of Acetabulifera, separating them from the Nautiloids among the Tentaculifera, with which they have been hitherto associated. All Nautili are smooth, whereas all Ammonites are ornamented on the surface. The ornamented shell of the Argonaut among the Acetabulifera closely resembles in its waving lines and projections the shell of the Ammonites. The want of a division into distinct chambers in the Argonaut shell presents no obstacle to the association, as there are other genera of this class with chambered shells. The Ammonites are geologically later than the Nautiloids, and thus the specimen exhibited is only another illustration of the law of correspondence between geological succession and order of position among living species.

Professor Bowen read a sketch of a Memoir, entitled "Some Remarks on the Meaning and Proper Application in Science of the Terms, *A General Fact*, *A General Law*, *A Cause.*"

Professor Lovering and Dr. B. A. Gould, Jr. criticised Mr. Bowen's use, in illustration of his views, of the term *attraction*, as understood in astronomical science.

Professor Lovering announced that the first part of the sixth volume of the Memoirs was ready for distribution to the Fellows.

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FROM APRIL 7, 1856, TO APRIL 25, 1857.

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Rapport du Superintendant de l'Education, pour le Bas Canada, pour 1854. 1 vol. 8vo. Quebec. 1855.

A Retrospective Glance at the Progressive State of the Natural History Society of Montreal. By Major R. Lachlan. 8vo pamph. Montreal. 1855.

Twenty-seventh and Twenty-eighth Annual Reports of the Natural History Society of Montreal. 18th May, 1855, and 19th May, 1856. 2 pamph. 8vo. Montreal. 1855-56.

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Annual Report of the Normal, Model, Grammar, and Common Schools, in Upper Canada, for the Year 1854. With an Appendix, by the Chief Superintendent of Schools. Printed by Order of the Legislative Assembly. 1 vol. 8vo. Quebec. 1855.

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William F. Channing, M. D.

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Four hundred and thirty-seventh meeting.

March 10th, 1857. — ADJOURNED STATED MEETING.

The Academy met at the house of John A. Lowell, Esq. The President in the chair.

The Corresponding Secretary read letters from the Hon. George S. Boutwell, accepting his election as a Fellow; from the Royal Academy of Sciences at Stockholm, the Royal Society of Sciences at Göttingen, the Society of Antiquaries, London, the Geological Society of London, the British Association, and the Librarian of the British Museum, acknowledging the receipt of the Academy's publications; and from the Imperial Academy of Naturalists, Breslau, and the Royal Academy of Stockholm, presenting their various publications; and from the Society of Sciences of the Netherland East Indies, concerning interchange of publications.

Professor C. C. Felton read the following paper, entitled,

" *Menander in New York.*

" Last winter, on my way to Washington, being detained in New York by the heavy snows which blocked up the railways, I took the occasion of visiting for the first time Dr. Abbott's collection of Egyptian Antiquities. I was surprised and delighted with the extent and value of the collection. Dr. Abbott, residing for many years as a physician in Egypt, had excellent opportunities for securing the most rare and precious antiques, from the natives who discovered them; and he has used his opportunities to good purpose. Contenting myself with a general survey of these treasures, and reserving a more particular examination until my return, I intended to spend some time in the city for this purpose alone.

" In about a fortnight I returned; but, having lodged at the National Hotel at the time it was visited by the mysterious disease which has sent several to their graves, and caused many to linger for months in a state of great suffering and danger, I was myself too ill to accomplish all I hoped and proposed.

" The catalogue of this Museum contains considerably over a thousand articles. Among the most curious are several mummies of the

Bull-god, Apis, in excellent preservation, not a single specimen of which is to be found in any European collection; papyri, in better preservation than any in Europe; human mummies; rings, necklaces, &c.; and writing tablets of the Greek or Ptolemaic period.

"The principal papyri are,— 1. A Funeral Papyrus, or Book of the Dead, twenty-two feet long, written in hieroglyphic characters, and perfect from end to end, not a single character injured or effaced in its entire length. 2. A more magnificent papyrus, thirty-six feet in length, written in the hieratic character, and so perfectly preserved, that it has been simply unrolled, without stretching it on paper or cloth. It would be very desirable that these splendid documents should be published, and thus submitted to the examination of the learned world. Lepsius, the great Egyptologist of Berlin, it is well known, published the Turin Papyrus of the Book of the Dead. This was the first Egyptian book ever printed with movable types, and its appearance formed an era in Egyptian studies. It would be honorable to the scholarship of our country if these papyri — in better preservation than that at Turin or any others now known in Europe — could be printed in a similar style here, and so made accessible, like the Lepsian Book of the Dead.

"Among the rings is the signet ring belonging to Suphis or Cheops, whose name and attributes are beautifully cut in hieroglyphics upon its surface. It is of solid gold, and is stated to weigh about three sovereigns. This is quite unique. Nothing of the kind in the European galleries equals it in rarity and value. Of the minor curiosities of the Museum, one of the most interesting is a rude but spirited drawing, representing a fox presenting to the lion, as king of the beasts, a plucked goose. It is a singular indication of the satirical turn of the old Egyptians, and shows that the story of Reynard's tricks is not wholly a modern invention.

"But what attracted my chief attention, in the second visit I paid to the Museum, was the tablets. Of these there were five or six, in various degrees of preservation. The keeper of the collection courteously allowed me to take them from the glass case, and examine them at my leisure. Most of them are of a small size, oblong in shape, about six inches in length and four in width. They are made of wood, hollowed on one side about a quarter of an inch in depth, leaving a border all round of half an inch in width, like the frame of a small slate. They are inlaid with a thin coating of wax, or some similar preparation. The border of one side is pierced with several holes, as if for the insertion of a cord or wire. Two of these tablets might be put together without touching the waxen surface, so as to form what is technically called a *diptychon.* The wax is entirely hardened, and nearly as black as iron.

"One of the tablets is in almost complete preservation. The wax is slightly worn in a few places. All of them contain written characters. Upon carefully examining those upon the best-preserved tablet, with the aid of a magnifying-glass, I found nearly all of them could be made out. A few were obliterated. After an hour or two of inspection, I succeeded in copying all except the first syllable of a single word, which ended a line. Here was an excellent opportunity for critical conjecture, which I eagerly seized, supplied the missing syllable, and completed the writing. Before, however, relinquishing the interesting inquiry, I proceeded to examine the fragments of another tablet. Nearly all the writing on it was obliterated or destroyed; but enough remained to show that the passage was the same as that on the first, though not so carefully copied. Luckily the mutilated word which I had patched up by my conjectural criticism was entire, and proved, as generally happens in such cases, that my conjecture was wrong. But I was thus enabled to complete the text, without the slightest doubt as to any part of it.

"It is very neatly and finely written, evidently by a careful chirographer, while the others, which appear to be copied from this, are more like the writings of schoolboys. This curious fact lends countenance to the opinion given in the catalogue, that the tablets were used in some Alexandrian school, by a Greek schoolmaster, who was teaching boys to write Greek; and it is evident that they belong to the age of the Ptolemies. The characters are of the square or uncial form, and closely resemble those of the Alexandrian Greek manuscripts; for example, the lately discovered papyrus fragments of Hypereides. The writing is not only excellent, in the copy which I suppose to have been set by the master, but, when a word is divided between two lines, the syllabication is careful and correct. All these circumstances indicate pretty clearly that the tablet is very old; probably three or four hundred years older than the oldest (a Latin one) in any European collection; even older, it is likely, than the age of Aristophanes the Grammarian, who invented accents for convenience in teaching Greek to foreigners.

"The lines, six in number, are written entirely across the waxen surface, leaving only a narrow margin on each side. They are as follows:

ΟΤΑΝ ΠΟΙΩΝ ΠΟΝΗΡΑ
ΧΡΗΣΤΑ ΤΙΣ ΛΑΛΗ ΚΑΙ
ΤΟΝ ΠΑΡΟΝΤΑ ΠΛΗ
ΣΙΟΝ ΜΗ ΛΑΝΘΑΝΗ ΔΙ
ΠΛΑΣΙΩΣ ΑΥΤΩ ΓΙΝΕ
ΤΑΙ Η ΠΟΝΗΡΙΑ.

Which, in common Greek character, without accents, is

οταν ποιων πονηρα
χρηστα τις λαλη και
τον παροντα πλη
σιον μη λανθανη δι
πλασιως αυτω γινε
ται η πονηρια.

"I brought the writing home in this shape, and whiled away some of the hours of a long National Hotel illness with a critical examination of the documents.

"On reading the passage, it becomes at once obvious that it has a rhythmical iambic beat, although the verses are not indicated by the way of writing, the reason being that the teacher wished to fill up the whole space with his copy. On further examination, they prove to be three iambic trimeters, constructed with the license of the comic senarius. It is necessary only to change the order of two words, *διπλασίως* and *αὐτῷ*, in order to make the second foot in the third line correct. The passage will thus stand, adding breathings and accents:

Ὅταν ποιῶν πονηρὰ, χρηστά τις λαλῇ
Καὶ τὸν παρόντα πλησίον μὴ λανθάνῃ
Αὐτῷ διπλασίως γίνετ᾽ ἡ πονηρία.

"These trimeters may be literally translated as follows:

When, doing ill, a man prates virtuous words,
Nor hides the secret from the stander-by,
Twofold to him becomes the wickedness.

"The style of these lines, and the peculiar turn of thought, remind one at once of the Fragments of Menander's comedies, several hundred of which have been preserved. The neatness of the expression, the subtile satire, and the elegance and spirit of the epigrammatic point, are quite in the manner of the accomplished Athenian. But a judgment of style on internal evidence alone, in a matter so remote from our own times, is not confidently to be relied upon. At all events, it seems quite certain that the passage is taken from some poet of the New Comedy, which delights in general delineations of character, and in sententious expressions embodying the wit and wisdom drawn from the observation of society; and, without further examination, it appeared to me more like the manner of Menander than that of any other Fragments that have come down to us of the works of that genial school. The tablet is very curious, because it contains more writing than any hitherto discovered, excepting those Latin tablets of the second century to which allusion has already been made. It is also curious, as containing a passage hitherto unknown, if not of Menander, certainly of some poet of the same Athenian age; and it is curious, because it shows that children in ancient times, in learning to write, had copies set them embodying some apophthegm, or moral sentiment, or condensed phrase of practical wisdom, or some side view of character, just as they do in our own schools. In fact, our 'Evil communications corrupt good manners,' quoted by St. Paul and translated by Tertullian, is from Menander.

"In the tablet which I suppose to have been used by a scholar, the master's copy is at first correctly followed; but the poor boy seems to have got wearied with such close attention, and towards the end ventured to write a word on his own account; for, instead of *γίνεται*, we have *φθαρήσεται*, which spoils both sense and metre.

"In order to settle, if possible, the question as to the authorship of the lines, I examined all the Fragments of the Attic comedians to be found in any of the collections, the National Hotel distemper continuing to afford me the requisite leisure. The result of this examination showed that the turn of expression, and several of the individual words, occur in many of Menander's known Fragments, but only once or twice in those of other poets. For example, passages beginning with *ὅταν*, signifying when this or that happens, then the result will be so and so, — as in Frag. V. of the Πλόκιον, or the *Necklace*.

Ὅστις πένης ὢν ζῆν ἐν ἄστει βούλεται
Ἀθυμότερον ἑαυτὸν ἐπιθυμεῖ ποιεῖν·
Ὁτὰν γὰρ εἰς τρυφῶντα καὶ σχολὴν ἄγειν
Δυνάμενον ἐμβλέψῃ, τότ᾽ αὐτὸν ἔστ᾽ ἰδεῖν
Ὡς ἄθλιον ζῇ καὶ ταλαίπωρὸν βίον.

Who, being poor, would in the city live,
Desires to make himself more sad in heart:
For when he sees the rich man's luxury
And how he lives at ease, then too he sees
How hard a life and wretched is his own.

" Also Frag. VI. of Δεισιδαίμων, the Superstitious Man. Frag. III. of Θησαυρός, and in the XIX., XX., XLV., XLVII., LVII., CXLVIII., CLXII., and CLXV. of the unplaced Fragments. For example, in LVII.:

Ὅταν πένης ὢν καὶ γαμεῖν τις ἑλόμενος
Τὰ μετὰ γυναικὸς ἐπιδέχηται χρήματα
Αὑτὸν δίδωσιν, οὐκ ἐκείνην λαμβάνει.

When the poor man, resolving he will wed,
Looks to get money with the wife he woes,
Himself he gives, but her he does not take.

" Among the Menandrian Fragments, about fifteen have this form; but the examples cited will suffice to illustrate this point of the argument.

" The expression πονηρὰ ποιῶν occurs in one of the Fragments attributed to Menander. The adjectives χρηστός and πονηρός often occur as antitheses; and in one instance they are found in the masculine as designations of the opposed characters *good* and *bad*. The passage is from the Cnidia, preserved by Stobæus:

Καὶ γνήσιος
Ὁ χρηστός ἐστιν, ὁ δὲ πονηρὸς καὶ νόθος.

" The word λαλέω meant originally *to prate* or *babble*. It is used in this sense exclusively by Aristophanes; but soon after his time it began to be employed as the equivalent of λέγω, *to speak*, or *talk*. It is used by Menander generally in the sense of *to prate*, but also once or twice in the sense of *to speak*. In the Septuagint, which belongs to the third century before Christ, it is used exclusively in the latter sense, and in the New Testament the usage is the same.

" In our passage λαλέω evidently is employed in its original sense of *prating*. This would seem to point to a period as ancient as Menander, or about his time. The verb and the corresponding adjective occur in several of his acknowledged Fragments in this sense; as Frag. I. Δύσκολος, " περὶ χρημάτων λαλεῖς."

" These particulars show that, in the general structure of the passage and the minute details of expression, it bears a closer resemblance to the style of Menander than to that of the other comic poets, so far as we can judge by the Fragments that have been preserved.

"I may add, that the works of Menander were favorites among the Greeks of Egypt and at the court of the Ptolemies, and that he was invited by the king himself to take up his abode in Alexandria.

"Menander was born B. C. 342, the same year with Epicurus, and died B. C. 291. His father, Diopeithes, was an Athenian admiral, whose fame chiefly depends on his having been defended by Demosthenes when brought to trial in an Athenian court upon the complaints of King Philip. Menander wrote from a hundred to a hundred and ten plays, and fragments from about ninety have been preserved, with some five hundred unplaced fragments. They vary in length from one word to twenty or thirty lines, giving a sufficiently accurate notion of his general style, and of the tone of that department of Greek poetry to which his works belong.

"His plays were universally esteemed as models of grace, urbanity, and elegance, and they continued to be played at least down to the time of Plutarch, — perhaps much later.

"He declined King Ptolemy's invitation. This circumstance was seized upon by Alciphron, a writer of the second century, and author of an agreeable series of fictitious letters, among which is one from Menander to Glycera, his Athenian mistress, in which he tells her of the king's invitation, and his refusal of it, with a great many expressions of ardent affection. 'I have received,' he writes, 'from Ptolemy, the king of Egypt, a letter, in which he makes all sorts of requests, and, like a king, promises, as the saying is, every blessing on earth to me and to Philemon. . . . . Philemon will do as he pleases. But I cannot endure the project; for, by Athena, you Glycera have always been, and shall still be, to me, Intellect, Council of Areopagus, Heliastic Court, — all in all. . . . . I have not the least idea of making a voyage to Egypt, — so distant a kingdom, — by the Twelve Gods, not I. If Egypt were in the neighboring island of Ægina, I should never think of quitting my kingdom, which is thy love, to behold, alone in such a multitude of Egyptians, without my Glycera, nothing but a peopled solitude (ἐρημίαν πολυάνθρωπον ὁρᾶν). I would not exchange the dramatic festivals, the exercises of the Lyceum and the sacred Academy, for all the gilded splendors of courts. I would rather be crowned with the ivy of Bacchus than the diadem of Ptolemy, my Glycera sitting in the theatre and looking on. Where, in Egypt, shall I see the assembly and the ballot? and where the democratic multitude sporting their liberty? where the popular elections, the Agora, the courts, the beautiful Acropolis, yonder neighboring Salamis, and the Strait, Psyttaleia, the field of Marathon, — all Hellas, all Ionia, all the Cyclades in Athens? Shall I quit all these and my Glycera, stray away to Egypt, to get gold and silver and wealth? And Glycera beyond the sea from me? Will not all this be poverty without her?'

"These may well be supposed to be the arguments that kept Menander at home. Athens even now is in many respects the most enchanting city in the world. Its wonderful ruins, its translucent air, its blue skies, — the Cephissus, the Ilissus, — the weird old olives of the Academy, — the play of golden beams peering over Hymettus at dawn, the purple veil of the mountains at evening, — the silver moonlight poured over the columns of the Parthenon on the Acropolis, — the remnants of the theatre, — the Bema, — Ægina, Salamis, — the memories of Æschylus, Sophocles, Aristophanes, Menander, Socrates, Plato, Aristotle, Demosthenes, — the urbanity of its present inhabitants, — the University and its learned professors, — make it even now the darling of the East, the beloved object of every scholar's affections, the hope and pride of regenerated Hellas. So I think Menander was right in rejecting the princely offers of the Ptolemies. His works were none the less popular there; copies were to be found in all the libraries; they were the favorite subjects of the criticism of the professors in the Museum and the Serapeum. They were known and read at Constantinople probably down to the time of the Crusaders. It was natural that sentences from works so esteemed should become common property, — should be quoted by writers, selected by schoolmasters, copied by schoolboys. But it is singular that one of them should make its first appearance in modern times at New York."

Mr. G. C. Ayling exhibited to the Academy a new quadrant, known as Hedgcock's Quadrant, by which he claimed to be able to determine the position of any point on the earth's surface without the aid of sun, moon, or stars. On motion, the instrument was referred to a committee consisting of Professor Lovering, J. I. Bowditch, G. P. Bond, and Dr. B. A. Gould.

Professor Agassiz said that similarity of form is an essential element in his definition of Families in the animal kingdom. Although this is true in general, he had found great difficulty in making the family of Naiades conform to this view. The different species of these shells are stamped with most of the principal features of a natural family, and yet they have very different forms; some being nearly square, others oblong, others cylindrical, others oblique, &c. They should agree in form, or else the definition of Family which he had adopted is not true. The mantle of these mollusks has not a uniform margin; being provided in different species with various fringes, and approaching by its edges in places, and at two points being united. The shell, by the waving outline of its lines of growth, conforms to the shape of the mantle within. It presents an oblong or ovate figure, on the edge of which are two projections, with a depression between; and all the wide differences in the apparent shape of these shells may be resolved into a greater or less degree of development of these parts; so that the Naiades do not in reality form an exception to the law.

Dr. A. A. Hayes exhibited specimens of the carbonaceous deposit, which has long been known to form in retorts used for decomposing coal.

"These specimens present the order of deposition from the first thin film, the lamellar coating, to the thick, compact, metallic-like mass, of a shining gray color, and very sonorous when struck. Those pieces which are very thin are also porous, and this character is preserved when the lamina becomes considerably thickened, while the final result of deposition is a compact solid of a general columnar form; the lamina being obliterated by infiltration of fine carbon and final cementation.

"The suite of specimens is intended to illustrate the following remarks.

"It is well known that the form of carbon here presented has been supposed to result from the decomposition of olefiant gas, by heat; olefiant gas being one of the products of coal decomposition, under certain conditions. Olefiant gas is represented by C_4H_4, the equivalent being four volumes, and when it is exposed to a temperature above redness, it deposits carbon in considerable quantity. If the exposure and heat be continued, the final result is carbon, as a precipitate, and hydrogen as a gas, free from carbon.

"To render probable the supposition of olefiant gas being the source of the gas-carbon, it has been generally stated that this bicarburet loses two of its four proportions of carbon by heat, and becomes converted into marsh gas, or light carburet of hydrogen, the formula of which is C_2H_4; and thus the definiteness of an exact result is presented.

"In the manufacture of gas for lighting, an increased temperature in the retort diminishes the illuminating power of the gas, and hence it has been assumed that the illuminating effect of the gas is diminished by a loss of the carbon contained in the olefiant gas, to which a large part of the light-giving quality has been attributed.

"It becomes an interesting point in general chemical science, to learn how far the facts gained by observation and experiment will sustain these assumptions which have been held in relation to the source of gas-carbon as above alluded to, and to inquire into its connections more particularly.

"Gas-carbon, in its difficult combustibility under a current of heated air, its relation to nitrates of the alkalies and sulphuric acid, must be classed with the carbon found in crude iron, and called graphitic carbon, or carbon in an allotropic state. It differs as much from lampblack and charcoal as these do from diamond, and in the artificial production of it, in all the cases hitherto observed, it has a certain relation to vapors. The fine specimens obtained when molten iron passes over moist earth, the metallic-like glazing of coke, and the lustrous residues of animal decomposition by heat, in presence of vapors, are all instances of the existing connection between vapors and this allotropic carbon.

"Taking the suite of specimens before us, the microscope enables us to see, in the early stages of deposition, that every part is vesicular; that mammillary forms result from the aggregation of the vesicles; and, pursuing these observations, we often find the broken vesicles filling vacant spaces between those more perfect, and a consolidation resulting from this arrangement. Where pendent parts exist, their sections show a perfectly regular building up from layers of sublimate, each layer being composed of vesicles, more or less broken; the thin shell of each exhibiting the superposition of layers which belongs to bubbles. The examination of hundreds of specimens will not show any departure from this character of a sublimate, produced either from its own vapor, or when transported by another kind of vapor.

We find also that those coal carbo-hydrogens which afford most vapors are those which leave in their decomposition most allotropic carbon; the natural bitumens affording the most remarkable and convincing results in this way.

"As the mechanical state of the gas-carbon, clearly shown under the microscope, as well as to the unassisted eye, is that of a solid left from a transporting vapor, observation indicates that it has been thus formed in the very compound atmosphere resulting from coal decomposition.

"It is a fact of chemical science, that olefiant gas, when heated, deposits carbon, and the fact can be easily demonstrated. But it is a remarkable feature in this decomposition, that the gas deposits its carbon in the form of *lampblack*, and the utmost reach of the means of control will not produce an aggregation of particles resembling charcoal. In high, or comparatively low temperatures, the deposition *never has the state of allotropic carbon*, and, chemically speaking, *there is no evidence that this form of carbon can result from olefiant gas changes.*

"If, however, vapors of bitumen are mixed with the olefiant gas, these vapors suffer decomposition by heat, and we easily obtain in the mixture vesicular, brilliant carbon in the allotropic state of gas-carbon: while the vapors solely much more readily afford this substance, in form and composition closely resembling gas-carbon.

"The subject, as I have studied it, appeared to possess interest in connection with the new facts which M. H. St. Claire Deville has lately published, respecting the graphitic form of Silicon, Boron, &c., in which a similarity of conditions of production is essential to the effect being obtained.

"In geological theory, the formation of anthracitic carbon in one case, and of graphite, with the gradations back to anthracite, in another, has hardly been explained; but if we are allowed to take the allotropic state of carbon as a distinctive character of that carbon, which has been sublimed, through the agency of its own, or more likely a foreign vapor, then the occurrence of these forms of carbon ceases to be anomalous, and accords with the circumstances under which many rocks have been produced. Graphite, graphitic carbon, graphitic oxide of iron, and, in general, sublimates composed of vesicular forms presenting laminæ, under this view become a class of bodies which owe their forms to the transporting power of vapors in motion.

"Another point observed in the decomposition of olefiant gas deserves notice. It is stated in most treatises on chemistry, and adopted as a matter of belief in the gas manufacture, that olefiant gas, when heated, deposits two of its four proportions of carbon, and, without change of volume, becomes marsh gas. It is barely possible, as an accidental circumstance, this proportion of carbon might be deposited, but it would take place, not as an experimental, but as a chance result. When olefiant gas is passed through ignited quartz, glass, or iron-turnings, it deposits carbon, *which has no definite relation to the composition of the gas*, a mixed gas being left, containing olefiant marsh gas and hydrogen. If the gas is repassed, the carbon may be nearly all abstracted, the marsh gas suffering decomposition.

"The conditions of olefiant gas heated in the products of coal decomposition are not such as to lead to a breaking up of its carbon arrangement, for there are many reasons for the statement, that this bicarburet is itself the result of change in the vapor of paraffine and other hydrocarbons of the oily characters.

"It seems, therefore, a correct deduction from observation and experiment, that gas-carbon is not produced from olefiant gas by deposition, but is a product of changes caused by heat in vapors of hydrocarbons, and that this allotropic carbon, in other cases, forms in the presence of vapors, which can transport carbon in the vesicular state."

Dr. Pickering referred to his having stated in print, that Manetho has given two distinct dates for the *Fall of Troy:* one of them (counting downwards in the Africano-Manetho Table) = B. C. 1127; and the other (in the Fragments preserved by Josephus, completed from the first-named source) = B. C. 1072. The earlier, being a Greek date, had always appeared doubtful, from the fact that Manetho was writing for a Greek Emperor. Since the publication of the above statement, Dr. Pickering has found that the Africano-Manetho Table contains both dates; the lower one in the Dynastic numbers, which (counted upwards from "B. C. 339," the adjustment supplied by Syncellus) give,

$$``9 + 38 + 20\tfrac{1}{3} + 6 + 124\tfrac{1}{3} + 150\tfrac{1}{2} + 40 + 6 + 89 + 120 + 130" = \text{B. C. } 1072\tfrac{1}{6}.$$

In the Armenian version of the Eusebio-Manetho Table, the earlier date has not been found; but the lower date is regularly given in the Regnal numbers, for, counting downwards,

B. C. 1413 — 11 — "8 — 15 — 5 — 68 — 40 — 194"
= B. C. 1072.

This lower date is confirmed by Ctesias, in his statement that the Assyrian Empire commenced 1000 years before the Fall of Troy, and lasted 1360 years: the dissolution of the Assyrian Empire being regarded by chronologists as fixed to the year B. C. 711, we have for Ctesias's date of the Fall of Troy,

B. C. 711 + "1360 — 1000" = B. C. 1071.

Further, the Greek discrepance of Fourteen Olympiads, or fifty-six years, occurring equally in Manetho's Tables, may be fairly applied to his Greek date of B. C. 1127: when,

B. C. 1127 — 56 = B. C. 1071,

Manetho's reckoning proves to be the same with that of Ctesias, and perhaps of the Greeks generally. Dr. Pickering thinks, therefore, that *B. C.* 1071 *is within a year of the Fall of Troy;* but has not ascertained whether the separate years will now close the chronological gap mentioned by Clinton. If so, and the date proves correct, it will carry the invasion of Greece by the Heraclidæ to the reign of Solomon.

Four hundred and thirty-eighth meeting.

April 14th, 1857. — ADJOURNED STATED MEETING.

The Academy met at the house of Dr. Hayward. The President in the chair.

The Corresponding Secretary read a letter from the Secretary of the Academy of Science of St. Louis, dated April 4th, requesting an exchange of publications on the part of the Academy.

Professor Lovering read the following report on the Hedgcock Quadrant, which was accepted and ordered to be placed on file.

"The committee appointed at the last meeting of the American Academy of Arts and Sciences to examine Hedgcock's Patent Quadrant, which was submitted to the Academy, have attended to the duty assigned to them and ask leave to report as follows.

"A full meeting of the committee was held on the 14th of March, at which Mr. Ayling was present. He then exhibited the new instrument, and attempted to explain the peculiarities and pretensions of it. The committee have handled the instrument, and have made themselves familiar with its construction; which, as compared with that of the ordinary quadrant, is defective in some points, and in others boasts a superfluous complexity which is the only thing original in the invention, or entitled to a patent.

"The claim made for the instrument, namely, that by it differences of latitude and longitude can be ascertained, rests upon no specified discovery of a new law in nature, and can be shown, when analyzed, to contradict the best determined laws. The reflecting quadrant is essentially an optical instrument. In optics there are only two ways known by which the *direction* of a ray of light can be altered, viz. *reflection* and *refraction;* and these changes of direction are the same for polarized as for unpolarized light. To maintain, therefore, that, when the images of an object have been brought into juxtaposition with the object itself, and the glasses clamped, this juxtaposition will not continue if the instrument is transferred to another place, and that the motion which must be given to the glasses to restore the juxtaposition will give the change of latitude and longitude, is to maintain neither more nor less than this, — that the laws of the reflection and refraction of light, which have been verified wherever there has been an observer for the last two hundred years, are not constant any longer, but have recently changed with the geographical position, and in such a marvellous way as exactly to suit the special claim of this Patent Quadrant.

"In opposition to any testimony that may be adduced to prove that this instrument has ever done what your committee say that it is incapable of doing, the committee would simply urge the unanimous and overwhelming testimony of mankind, not only of scientific men, but also of all engineers, surveyors, travellers, and sailors who have successfully determined their position by means of any quadrant or sextant, not one of whom has ever discovered that every observation he took with a reflecting glass was erroneous to the full extent of the difference between his latitude and longitude and some one standard place; as it must have been if the laws of light then changed with a change of parallels and meridians, and this Patent Quadrant is not a patent absurdity. Lastly, any change of latitude and longitude which could be detected with the new instrument by means of the assumed discovery in the laws of light, might also be found, and with equal facility, by means of any other reflecting quadrant or sextant; and certainly with greater accuracy, unless the construction of the Patent Quadrant is much improved. Hence Mr. Hedgcock's modification is, on his own principles, quite unnecessary.

"One absurdity naturally leads to other absurdities: the boldest of which here is another claim for the new instrument; viz. that by it the navigator can obtain his geographical position, whether he observes the sun in the heavens or a lamp in his cabin. This is a necessary consequence of any admission made in favor of the new instrument. For the laws of reflection, as far as *direction* is concerned, are the same for all light, artificial or natural.

"The committee would say, in conclusion, that they feel justified in rejecting the pretensions of this Patent Quadrant, as contrary not only to the universal teachings of science, but also to the constant experience of practical navigators; and that they regard the whole claim as simply ridiculous, and the language, printed and spoken, in which the claim has been asserted, as unintelligible nonsense; and the whole subject, therefore, as unworthy of the further attention of the Academy.

(Signed,) JOSEPH LOVERING,
B. A. GOULD, JR.,
G. P. BOND,
J. INGERSOLL BOWDITCH."

Dr. A. A. Gould presented, in the name of the family of the late Dr. Amos Binney, a former Fellow of the Academy, the third volume of his work on American Helices, containing the plates, now just completed.

Dr. H. I. Bowditch presented, in the name of Major Alvord of the United States Army, a copy of his paper on the "Tangents of Circles and Spheres."

Dr. Holmes exhibited and explained a new model of a stand for a microscope, contrived by himself, in which the various qualities of cheapness, portability, great stability, and most accurate and delicate adjustment were combined.

Four hundred and thirty-ninth meeting.

May 12th, 1857. — MONTHLY MEETING.

The Academy met at their rooms. Professor Treadwell, Vice-President, in the chair.

The Corresponding Secretary read letters from the Ethnological Society, London; the Royal Saxon Society of Sciences, Leipsic; the Royal Bavarian Academy of Sciences, Munich; and the Boston Society of Natural History, acknowledging the receipt of the Academy's publications; and from the Royal Bohemian Society of Science, Prague, presenting its Transactions.

Mr. G. P. Bond communicated the results of an examination of the photographs of the star Mizar (ζ Ursa Majoris), with its companion, and the neighboring star Alcor; specimens of which were exhibited.

"Daguerreotype images of the star Vega (α Lyræ) were obtained at the Observatory of Harvard College by the well-known artist, Mr. J. A. Whipple of Boston, on the 17th of July, 1850, and subsequently impressions were taken from the double star, Castor, exhibiting an elongated disc, but no distinct separation of its two components. These were the first, and, till very recently, the only known instances, of the application of photography to the delineation of the fixed stars.

"A serious difficulty was interposed to further progress by the want of suitable apparatus for communicating uniform sidereal motion to the telescope. This has now been supplied by replacing the original Munich clock of the great equatorial of the Observatory by a new one, on the principle of the spring governor, invented by the Messrs. Bond. This clock, which was made by Messrs. George and Alvan Clark of East Cambridge, carries the telescope with admirable evenness and regularity of motion.

"Immediately upon its completion, at the invitation of the Director of the Observatory, Messrs. Whipple and Black commenced a new series of experiments, and have succeeded in transferring to the plate, by the collodion process, images of the fixed stars to the fifth magnitude, inclusive, with singular and unexpected precision.

" The most remarkable instances of their success are the simultaneous impressions of the group of stars composed of Mizar of the second magnitude, its companion of the fourth, and Alcor of the fifth magnitude.

" The following measurements of the angular distance of the companion from Mizar were taken from the plates with the aid of the micrometer microscopes of the transit-circle. The distances represent the angles subtended by the images formed at the chemical focus, *and measured from the optical centre of the object-glass.*

Plate					Distance	
	I.	April	27th,	1857	Distance	= 14″.7
	VI.	"	27th,	"	"	= 14.7
	II.	"	28th,	"	"	= 14.6
	IV.	"	30th,	"	"	= 14.5
	VII.	May	6th,	"	"	= 14.5
	"	"	6th,	"	"	= 14.1
	"	"	6th,	"	"	= 14.3

" In consequence of a difficulty in the way of properly applying the microscope of the transit-circle, without incurring a sensible error of measurement independent of that attributable to the photographic process, the same plates (with the exception of II.) and six others were subjected to another form of micrometer, hastily arranged for the purpose, and less open to similar objection, though still sensibly imperfect. With this the following results have been obtained.

Plate.								
I.		April	27,	1857	Dist.	= 14″.44	Ang. of Pos.	= . . .
IV.		"	30,	"	"	= 14.34	" "	= . . .
V.		"	30,	"	"	= 14.77	" "	= . . .
VI.		"	27,	"	"	= 14.52	" "	= . . .
VII.	A.	May	6,	"	"	= 14.34	" "	= . . .
"	B.	"	6,	"	"	= 14.19	" "	= . . .
"	C.	"	6,	"	"	= 14.44	" "	= 146° 40′
1	A.	"	8,	"	"	= 14.59	" "	= . . .
"	B.	"	8,	"	"	= 14.55	" "	= 148 53
2	A.	"	8,	"	"	= 14.41	" "	= . . .
"	B.	"	8,	"	"	= 14.35	" "	= . . .
3	A.	"	8,	"	"	= 14.70	" "	= . . .
"	B.	"	8,	"	"	= 14.77	" "	= 147 55
					Mean	= 14.49	Mean	= 147 49

"For the sake of comparison, we will quote from the *Positiones Mediæ* of Professor Struve the following measurements of the same stars.

1755	Dist. = 13″.9	Ang. of Pos. = 143°.1	Obs. by Bradley.
1780	" = 14.1	" " = 146.8	" " Herschel.
1820.9	" = 14.63	" " = 146.2	" " Struve.
1830.6	" = 14.37	" " = 147.6	" " "
1840.8	" = 14.35	" " = 147.7	" " "
1847.6	" = 14.25	" " = 148.2	" " "

The mean of Struve's Distances is = 14″.40
" " " Positions is = 147°.4
" " Photographic Distances is = 14″.49
" " " Positions is = 147°.8

"The probable error of a single photographic distance is ± 0″.12, or quite as small as that attributed by Struve to a single direct measurement. The former method has thus in its first efforts attained the limit of accuracy beyond which it is not to be expected that the latter can ever be sensibly advanced. But the photographic process holds out a much better promise.

"The two principal sources of error by which it is affected are spots on the glass plate, or impurities in the coating in the neighborhood of the images, and slight departures from symmetry in their form, as yet noticed only when the plate has been exposed too long to the action of the light. The latter has been the case with most of the plates from which the above measurements have been taken, and they may in consequence be slightly affected. It is certainly to be anticipated, that, by the exercise of more care in regulating the time of exposure, the symmetry of the images can be secured. A microscopic examination will in most cases serve to distinguish accidental spots in the coating, or on the glass, from the molecules, which, by their aggregation, show the action of light.

"The real difficulty, perhaps insurmountable, which now prevents a most extensive application of photography to astronomy, is the deficient sensitiveness of the processes in use. Unless photographs of stars as low, at least, as the eighth magnitude can be obtained, its use must be restricted to comparatively few double stars. Should, however, this impediment be overcome, and photographic impressions be obtained from stars between the sixth and eleventh magnitudes, as has already been done for those between the first and the fifth, the extension given to our present means of observation would be an advance in the science of stellar astronomy of which it would scarcely be possible to exaggerate the importance."

Professor Bowen read an extract from a lecture of Professor Faraday, on "Conservation of Force," and remarked upon it as expressing views remarkably coincident with those offered by him in the paper read at a late meeting.

Professor William B. Rogers criticised the views in question at some length, and the subject of the nature of force was further discussed by Dr. Holmes, Dr. W. F. Channing, and Professors Bowen and Treadwell.

Dr. B. A. Gould, Jr. gave a history and description of the Calculating Engine of Babbage, and also of that of Mr. Scheutz of Stockholm, which was exhibited at the Paris Industrial Exhibition, and has since been purchased for the Albany Observatory.

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